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THE ROENTGENOLOGIC DIAGNOSIS OF TUMORS IN THE SELLAR REGION*

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WHEN there are symptoms suggestive of sellar or suprasellar tumor perhaps the first thought in the minds of all clinicians is to observe the roentgenographic appearance of the sella turcica. Since the observations of Oppenheim as to the roentgen changes in the sella turcica in acromegaly, there has been considerable interest in this bony structure because of the need of determining the presence of tumors of the hypophysis and the hope that something could be determined as to the size, development and pathologic changes which may be present in the pituitary gland.

Unfortunately the wide deviation, anteroposteriorly and laterally, and also the depth of the sella in apparently normal individuals make any estimate of the condition of pituitary gland (in most instances) extremely difficult. All too often roentgenograms of the sella are interpreted as indicating the presence of a hypophyseal tumor or an enlarged sella because the patient has clinical symptoms of such a lesion, when actually there is no roentgenologic finding of any diagnostic significance except perhaps a sella of more than average size. The roentgenologist is familiar with the fact that 50 per cent of all sellas are larger than the so-called average normal. The diagnosis of pathologic change should never be made unless the enlargement is unquestionably pronounced or unless there is evidence of decalcification or erosion of the clinoid processes or of the floor of the sella. Unfortunately, in most cases of long-continued intracranial pressure, the sella shows erosive changes not easily distinguished from those actually produced by the pressure of a contiguous lesion, either within the sella or outside the sella in proximity to the clinoid processes. Intrasellar lesions often produce the typical ballooned sella which has been so well described by Davis,[1] with elevation, backward displacement and erosion of the posterior clinoids, elevation of the anterior clinoids and depression of the sellar floor. These signs may be definite indications of the presence of a pituitary tumor. A lesion above the sella may flatten the sella, depress and erode the clinoids and produce a definite picture of suprasellar tumor. A lesion on either side may depress the sellar floor and erode the clinoids on one side, producing a duplication of the floor at a different level as shown on a lateral roentgenogram of the head,[5] and may perhaps be best demonstrated by an anteroposterior view of the sella. Erosion of the sella may also be caused by an aneurysm of the circle of Willis or of the internal carotid artery. Malignant tumors often produce destruction without any evidence of displacement because the lesion invades and incorporates the bone in the tumor growth.

* Read at the Thirty-fifth Annual Meeting, American Roentgen Ray Society, Pittsburgh, Pa., Sept. 25–28, 1934.

Fortunately for the roentgenologist most tumors in the sella and its immediate neighborhood produce these typical appearances on the roentgenogram. There are, however, many sellar lesions accompanied by early eye changes and clinical evidence of tumor in which there are no definite changes in the bony structures of the sella turcica; these lesions demand other methods for their detection. Calcification which produces increased density on the roentgenographic film is perhaps the next most important aid in determining the existence and exact location of a tumor in the region of the sella. There are many of these lesions, however, that do not produce sufficient calcium deposit to produce contrasting density on the roentgen film. Calcification is usually indicative of the presence of a tumor but may not determine accurately its location, for the calcification may be in the center of the lesion, at its periphery or in the tissue adjacent to the lesion. Evidence of increased density or calcification is usually sufficient to determine the presence and approximate situation of a great number of suprasellar lesions. Calcification in intrasellar lesions is so rare that this method of identification is of little importance in this type of tumor. McKenzie and Sosman[4] reported a group of 35 cases, of which 71 per cent exhibited evidence of calcification. Among these 35 cases, there was calcification within the sella in only 2 cases. A recent review of a series of 12 cases of suprasellar tumor in which operation was performed by Dr. Gardner of our Clinic shows that calcification was present in 5 instances. In a group of 12 cases of intrasellar tumor there was calcification in only 1 case.

The necessity for other roentgenologic methods of diagnosis is at once apparent in the case of lesions without calcifications or characteristic sellar deformities. As has been the case in the development of other roentgenologic diagnostic methods, some type of contrast medium is utilized. The introduction of air into the basilar system and ventricles, particularly into the third ventricle, seems to be the logical procedure. Roentgenologists are much indebted to Dandy for the introduction of this procedure, encephalography. Encephalography has been developed to such a degree of usefulness that it is definitely indicated in suspected presence of suprasellar lesions or of intrasellar lesions when there is some question as to the presence of a tumor. Many surgeons have attempted to discourage this method of examination on the ground that it is accompanied by an unwarranted risk to the patient, particularly in those cases in which there is evidence of intracranial pressure. In 1932, Gardner[2] reported 19 patients with increased intracranial pressure in whom encephalography performed with proper precautions as to technique was accompanied by only a minimum of risk. Stimulated by this encouraging report, a constantly increasing number of cases have been subjected to pneumoroentgenologic examination, with constantly increasing appreciation of the value of the procedure. In 1933, Dr. Gardner and I[3] reported the results of encephalographic examination in 50 cases of surgical lesions of the brain. Since that time practically all patients with symptoms of a suprasellar lesion have been examined in this manner at the Cleveland Clinic. Of the 12 cases of suprasellar tumor reviewed in this series, an encephalogram was made in 9 cases. In 7 of these the tumor either was visualized or the deformity of the ventricles, particularly of the third ventricle, and of the basilar cisterns confirmed the presence of a tumor of the suprasellar type. In the other 2 cases there was nothing in the encephalogram to indicate the presence of a suprasellar tumor. In the 3 cases in which encephalographic examination was not done, the presence of the tumor was confirmed by the evidence of calcification in 2 cases, and by definite sellar changes in the other. In the 12 cases of intrasellar tumor, encephalography was employed in only 2 instances. One of these showed the tumor protruding up from the sella and this finding confirmed the clinical

diagnosis. In the other case, the encephalogram ruled out the presence of a tumor above the sella. In the other 10 cases of tumor within the sella, one was identified by the presence of calcification of the sella and 9 by the changes in the sella turcica, together with the characteristic clinical symptoms of pituitary tumor.

The findings of importance on the encephalogram in cases of suprasellar tumor are (1) complete or partial obliteration of the cisterna chiasmatis by the tumor, (2) elevation of the floor of the third ventricle or encroachment on its anterior portion, (3) separation of the anterior horns of the lateral ventricle, and (4) the visualization of the tumor mass by the surrounding air in the basilar cisterna and third ventricle. Through obliteration of the cisterna chiasmatis, these tumors usually diminish the number and size of the cortical pathways in the cerebral areas.

The 24 cases in this series included the following types of tumor, all of which were confirmed by operation: 11 pituitary adenomas and 1 medullary blastoma among the 12 intrasellar lesions and 6 craniopharyngiomas, 1 glioma, 1 papillary carcinoma, 3 suprasellar cysts of the Rathke pouch type, and 1 meningioma among the 12 suprasellar tumors.

This series of cases is small, but it offers definite evidence of the value of encephalography as a diagnostic aid. In this discussion no mention has been made of the clinical symptoms and the ages of the patients, which factors are of extreme importance in forming a final diagnosis, because it is desired to place special emphasis on the contribution of roentgenology to the diagnosis of sellar and suprasellar tumors.

SUMMARY

In reviewing a series of 24 cases of tumor in or near the sella, 12 intrasellar lesions and 12 suprasellar lesions, the roentgenologic criteria which are observed in roentgenograms of the sellar region and in encephalograms made following the injection of air are discussed.

The signs on the roentgenogram indicative of pathologic changes in or near the sella include decalcification and erosion of the clinoid processes, calcification, and elevation or depression either of the roof or floor of the sella.

When these definite roentgenographic signs are absent, encephalography is employed. This method is most valuable in the case of a suprasellar tumor which may be visualized directly or may be producing a deformity of the ventricles or of the basilar cisterns. Encephalography is seldom necessary in making a diagnosis of intrasellar tumor, which usually produces sufficient calcification or deformity to make possible the diagnosis from the roentgenogram.*

* For discussion see page 764.

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ENLARGEMENT OF THE DEFECT IN THE AIR SHADOW NORMALLY PRODUCED BY THE CHOROID PLEXUS

ITS OCCURRENCE AFTER VENTRICULAR PUNCTURE*

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IN ONE of the papers on "the demonstration of normal cerebral structures by means of encephalography"[1], a defect was described in the lower wall of the lateral ventricle, located at the junction of the body with the occipital and temporal horns. This defect was frequently seen in the normal encephalogram in both lateral and anteroposterior views, and was shown to be due to the projection of the glomus of the choroid plexus into this portion of the lateral ventricle (Fig. 1).

FIG. 1. Roentgen ray No. 24530. Lateral encephalogram showing a defect in the atrium of the lateral ventricle produced by the normal glomus (arrow).

This irregularity in the outline of the wall of the ventricle produced by the glomus of the choroid plexus was also visible in the roentgen films of cases in which the air had been introduced directly into the ventricles instead of by the lumbar route.

A review of 100 *ventriculograms* showed 41 instances in which there was a demonstrable defect in the air shadow of the ventricle produced by the glomus. In *encephalograms* the frequency of the corresponding glomus defect was somewhat higher (50 per cent). The average measurements of the glomus defect in the lateral horizontal films in the 41 ventriculograms was 10×6 mm. (60 sq. mm.). The maximum measurements which were considered within normal limits were 15×15 mm. (225 sq. mm.). Since the defect is most often visible in the lateral film, taken with the patient in the horizontal position, the measurements were made in only one plane.

In a series of encephalograms the average measurements of the defect or notch were practically the same as in the ventriculograms. Moreover, in the routine examination of 1,400 *encephalograms* no abnormally large glomus defect was ever noted.

Contrasted with these were 6 *ventriculograms* in which the measurements were considered abnormal. The average for the latter cases was 29×14 mm. (406 sq. mm.), the maximum being 40×20 mm. (800 sq. mm.), and in these patients the question was raised whether there was a tumor in or adjacent to the plexus or whether the defect was due to some other cause. Aside from the relative rarity of tumor of the choroid plexus or of a neoplasm of the neighboring cerebral substance which

[1] Dyke, C. G., and Davidoff, L. M. The demonstration of normal cerebral structures by means of encephalography. I. The choroid plexuses. *Bull. Neurol. Inst.* N. Y., 1932, *2*, 331–346.

* From the Departments of Roentgenology and Neuro-surgery, Neurological Institute of New York. Read at the Thirty-fifth Annual Meeting, American Roentgen Ray Society, Pittsburgh, Pa., Sept. 25–28, 1934.

could produce so localized a projection into the ventricle, further studies soon demonstrated that the abnormally large defects observed in the *ventriculograms* would have to be explained on some other basis. Encephalograms made several days later, in some of the same cases, showed the defect to have decreased in size. This led to the conclusion that temporary swelling in the region of the glomus of the choroid plexus may be the result of trauma to this structure or the neighboring ventricular wall, during ventricular puncture, as the following experiences demonstrate:

Case 1 (N.I. No. 12123). R. F., a white female, aged forty-five, entered the hospital April 7, 1932.

Complaints. Vertigo, vomiting and headache.

Present Illness. For a period of four years prior to admission, the patient had suffered from paroxysmal attacks of vertigo, vomiting and headache at irregular intervals. The last attack occurred two months before admission during which there was numbness of the left arm and leg.

Neurological examination was negative except for a slight left hyper-reflexia and nystagmus on lateral and upward gaze.

Ventriculograms. Ventriculography done on May 23, 1932, showed the lateral ventricles to be slightly enlarged and a large porencephalic defect in the right frontal lobe. In addition to this, there was evidence of a large irregular mass 30×14 mm. in size, in the region of the glomus of the left lateral ventricle (Fig. 2).

Fig. 2. Case 1. Roentgen ray No. 22293. Lateral ventriculograms showing an enlarged defect in the atrium of the left lateral ventricle (arrows).

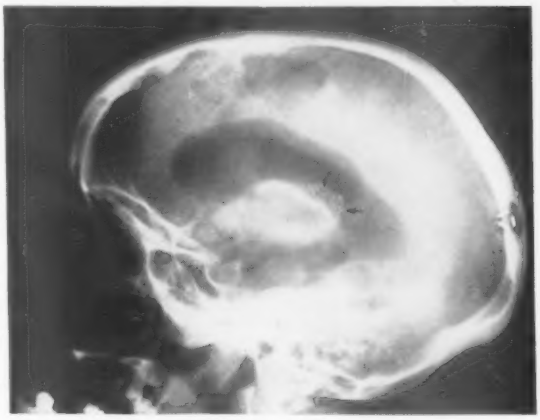

Fig. 3. Case 1. Lateral encephalogram done four days later showing a decrease in the size of the defect in the left lateral ventricle (arrows).

Impression. Porencephalic defect of right frontal lobe with enlargement of the defect in the region of the glomus of the left choroid plexus.

Encephalograms. Encephalography done on May 27, 1932, showed the lesions as described after ventriculography, but the defect in the left lateral ventricle was much smaller (Fig. 3) and measured 23×10 mm.

Comment. The large defect in the left lateral ventricle was situated in the area normally occupied by the glomus. Although both ventricles had been punctured, the abnormality was present only on the left side. Encephalograms were made four days later and they showed that the defect was definitely smaller. The spinal fluid obtained at encephalography was xanthochromic. The porencephalic defect in the right frontal lobe was sufficient to account for the patient's symptoms. As a result of all of these facts it seemed likely, therefore, that the enlargement of the glomus notch was transient and probably related to the ventricular puncture.

It was not until a year and a half later that we encountered another patient whose ventriculograms showed an enlarged glomus defect apparently unrelated to his disease. The case was one of hemangioblastoma of the cerebellum.

CASE II (N. I. No. 17733). J. C., a white male, aged fifty, entered the hospital on October 25, 1933.

Complaints. Headaches and failing vision.

Present Illness. About two years prior to admission, the patient began to suffer from paroxysmal attacks of headache increased by flexion of the head. Other symptoms did not occur until one month before admission when he began to lose vision rapidly.

Neurological Examination. The examination showed bilateral papilledema with optic atrophy and diminished visual acuity and slight ataxia, drifting, past-pointing and adiadochokinesis in the left upper extremity.

Clinical Diagnosis. Possible cerebellar tumor.

Ventriculograms. On November 4, 1933, a unilateral ventricular puncture was done through the right parietal bone posteriorly. The lateral ventricles were moderately and symmetrically dilated, as were the third ventricle and aqueduct of Sylvius. The fourth ventricle was not visualized. In the right lateral ventricle, occupying the position of the glomus of the choroid plexus, was a large, sharply outlined filling defect measuring 40×20 mm. (Figs. 4 and 5). *Impression.* Probably cerebellar tumor.

In Case I a similar shadow in one lateral ventricle seen in the ventriculogram was found to have largely disappeared in the encephalogram made four days later. Therefore, in this patient, in order to confirm the diagnosis of cerebellar tumor and to make certain that the defect in the wall of the ventricle had no relation to the symptoms encephalography was done.

FIG. 4. Case II. Roentgen ray No. 26280. Lateral ventriculogram showing a large defect in the atrium of the right lateral venticle (arrows).

FIG. 5. Case II. Posteroanterior ventriculogram showing the large defect in the atrium of the right lateral ventricle (arrows).

Encephalograms. On November 10, 1933, air was injected by the lumbar route, but the major portion of the air was arrested opposite the arch of the atlas. However, sufficient air remained in the ventricles from the ventriculogram done six days previously, to show that the defect in the right ventricle had largely disappeared (Fig. 6). *Impression:* Cerebellar tumor.

Hospital Course. The patient was operated upon and recovered satisfactorily after the removal of a hemangioblastoma of the cerebellum. He was in good health when last seen one year after the operation.

Comment. The defect seen in the right ventricle corresponded to the position of the glomus of the choroid plexus but was much too large for a normal glomus. Furthermore, the mass which bulged into the ventricle was situated on the side of the ventricular puncture and was on a line with the direction which the needle had taken. Encephalograms, made six days after the ventriculograms, showed the defect to have largely disappeared, leaving a notch in the ventricle which corresponded to the size of a normal glomus. The cerebrospinal fluid obtained at encephalograph-

ic examination was yellow and contained 1,300 red blood cells per cubic millimeter. The lesion from which the patient suffered was a hemangioblastoma of the cerebellum, and it was highly improbable that there was any connection between the cerebellar neoplasm and the defect in the outline of the one ventricle after ventriculography.

A few months later another case clinically different from Cases I and II, but again showing a temporary enlargement of the glomus notch in the left lateral ventricle, came under observation.

Case III (N. I. No. 18183). A. S., a white female, aged thirty-seven, entered the hospital on December 4, 1933.

Complaints. Blurring of vision, dull pain in the right eye and buzzing in the right ear.

Present Illness. About five months before admission to the hospital the patient noticed a blurring of vision in the right eye accompanied by headaches in the right supraorbital region. She also noticed a buzzing in the right ear which was synchronous with the heart beat and could be stopped by pressure on the right side of the neck. These symptoms continued up to the time of admission.

Fig. 6. Case II. Lateral encephalogram made six days after ventriculography with residual air from the previous air studies in the right lateral ventricle. The defect in the atrium is much smaller than six days before.

Neurological Examination. The only positive finding was a bilateral papilledema of three to four diopters.

Roentgen Examination. The plain films of the skull showed evidence of increased intracranial pressure. *Ventriculograms:* Ventriculography after bilateral ventricular punctures on December 14, 1933, showed slight dilatation of the lateral ventricles, but no localizing evidence of tumor. A filling defect was noted in the region of the glomus of the left choroid plexus which measured 20×15 mm. *Impression:* No evidence of tumor. *Encephalograms:* Encephalography done on December 18, 1933, showed that the defect in the left lateral ventricle was definitely smaller than that seen on the ventriculograms.

Subsequent Course. As there was no evidence of a localized disease, a right subtemporal decompression was done, after which the headaches and papilledema subsided. The patient was discharged improved on December 28, 1933. She was seen repeatedly at the Follow-Up Clinic and at her last visit, July 12, 1934, she was in good health.

Comment. Again a mass was outlined corresponding in position to, but definitely larger than, the normal glomus shadow. It was located on a line with the needle puncture, and although both ventricles had been tapped, the defect was seen only on one side. At the subsequent encephalography the shadow was definitely smaller than before. The cerebrospinal fluid at encephalography contained 403 erythrocytes while four days prior at ventriculography the fluid contained 3,150 erythrocytes. The papilledema and the slight ventricular dilatation were probably due to a hypersecretion of cerebrospinal fluid on a toxic or inflammatory basis, and the symptoms disappeared after a palliative subtemporal decompression.

Our experience with the previous three cases led to the conclusion that the enlargement of the glomus notch in the following patient was not related to the symptoms and an encephalogram was therefore deemed unnecessary. The essential features of the case were:

CASE IV (N. I. No. 20511). T. H., a white female, aged twenty-two, entered the hospital on July 3, 1934.

Complaints. Headache, vertigo, dimness of vision, and vomiting.

Present Illness. In June, 1933, the patient began to suffer from attacks of bitemporal headache. Shortly thereafter she developed visual disturbances consisting of blackness before her eyes and dizziness. Three or four times during the year she had spells of vomiting.

Neurological Examination. Except for bilateral papilledema of three diopters, the examination was negative.

FIG. 7. Case IV. Roentgen ray No. 28258. Lateral ventriculogram showing a large defect in the atrium of the right lateral ventricle.

Roentgen Examination. The plain films of the skull showed atrophy of the posterior clinoid processes and dorsum sellae. *Ventriculograms:* Ventriculography done on July 5, 1934, through a single ventricular puncture in the right posterior parietal region, showed moderate bilateral, symmetrical dilatation of the lateral and third ventricles and of the aqueduct of Sylvius. The ventricles were in normal position. Only the left side of the fourth ventricle was filled with air. There was evidence of a soft tissue mass in the region of the glomus of the right ventricle. The defect was round and measured 20×20 mm. in diameter (Fig. 7). *Impression:* Cerebellar tumor.

Operation. A suboccipital exploration on July 11, 1934, revealed tough, vascularized adhesions of the cerebellum to the margins of the foramen magnum. There was no evidence of tumor. The adhesions which were most marked on the right side were separated.

Comment. As in the other cases, the defect in the ventricular outline corresponded to the position of the glomus of the choroid plexus on the side of the ventricular puncture. The trephine hole in the skull was so placed that the cannula must have entered the ventricle at the atrium. As it was evident from the ventriculogram that the lesion responsible for the clinical picture was in the posterior fossa, encephalography was not done. From our previous experiences we were led to conclude that the defect in the outline of the ventricle was due to trauma to the glomus of the choroid plexus or a neighboring portion of the ventricle wall.

A study of the relation between the position of the large defect in the lateral ventricle and the situation of the trephine opening in the skull made for the ventricular puncture showed that the direction in which the needle is usually passed is such that injury to the glomus of the choroid plexus or a nearby portion of the wall of the ventricle can easily be produced.

That this may actually occur was demonstrated by the following case in which, at post-mortem examination, there was a hematoma of the wall of the ventricle near the glomus of the choroid plexus.

CASE V (N. I. No. 18594). L. L., a white female, aged forty-three, entered the hospital on January 15, 1934.

Complaints. Headache, vomiting, dizziness and confusion.

Present Illness. Six months prior to admission the patient began to have attacks of left frontoparietal headache associated with noises in the ears and dizziness, followed five months later by projectile vomiting. She became confused, disoriented, incontinent and complained of blurred vision.

Neurological Examination. The patient showed motor apraxia, astereognosis and mild aphasia. There was marked tremor of the right hand, left hyperreflexia and weakness. The pupils were unequal, the right was larger than the left, and both reacted poorly to light. There was a bilateral papilledema of two diopters.

Roentgen Examination. Plain films of the skull were normal. *Ventriculograms:* On January 18, 1934, bilateral trephine openings were made and needles inserted and air injected into both lateral ventricles. The roentgen films showed a moderate asymmetrical dilatation of the lateral ventricles and a localized deformity in the medial portions of the roofs of both lateral ventricles in the anterior thirds of the bodies. The quantity of air was insufficient to outline adequately the atria of the lateral ventricles. The findings indicated a tumor between the anterior portion of the lateral ventricles.

Operation. January 22, 1934: A right transfrontal craniotomy was attempted but had to be abandoned before the dura mater was opened because of the poor condition of the patient. The same evening she died.

Post-mortem Examination. Aside from the primary lesion—a glioma situated in the genu of the corpus callosum—a hematoma was found in the atrium, extending into the occipital horn of the left lateral ventricle. It was about 20×15×15 mm. in size and was situated posterior and dorsal to the glomus of the choroid plexus. Serial macroscopic sections of the left hemisphere from the glomus of the choroid plexus posteriorly showed a straight hemorrhagic tract about 5 mm. in diameter at the ventricular end (Fig. 8), decreasing progressively in size toward the surface of the brain. On the cortex it was only a blood-stained speck about 1 mm. in diameter. This represented the tract of the needle which had been inserted through the trephine into the ventricle four days previously.

Comment. It was unfortunate that after ventriculography the lateral ventricles did not contain sufficient air to outline their posterior portions. The largest area of hemorrhage within the occipital lobe was nearest to the wall of the lateral ventricle and the smallest near the surface of the brain. This made it evident that the bleeding was not the result of injury to a cortical blood vessel but to a vessel near to or within the ventricle. This post-mortem demonstration of actual trauma to the wall of the ventricle near the glomus of the choroid plexus from ventricular puncture was the final evidence necessary to support the roentgen diagnosis and the interpretations of the roentgenograms made in the 4 previous cases.

A re-study of the ventriculograms of 100 patients revealed only 1 case in which an enlarged glomus defect was present on the side contralateral to the puncture. This, of course, could not be explained on the basis of trauma to the choroid plexus or adjacent ventricular wall.

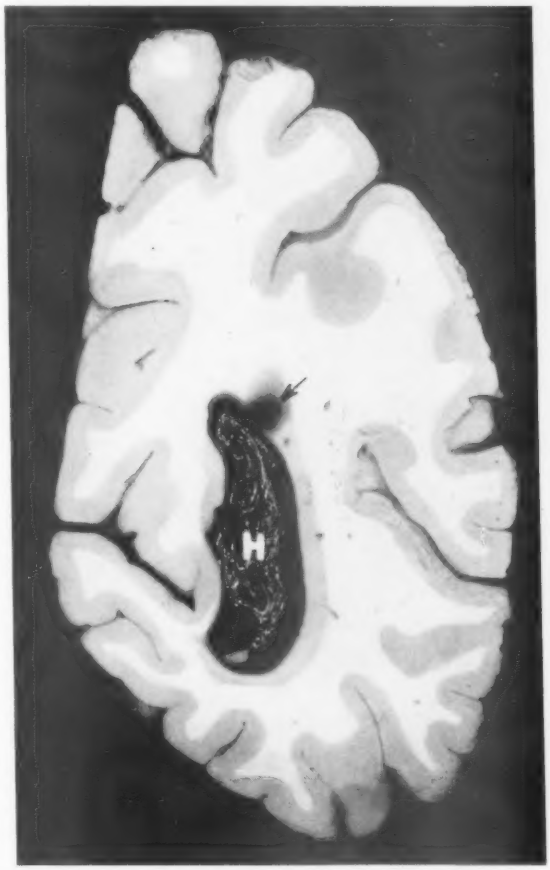

Fig. 8. Case v. Coronal section of the left hemisphere through the atrium of the ventricle showing a large hematoma (*H*) following ventricular puncture. Note the hemorrhage in and around the needle tract (arrow).

Case vi (N. I. No. 19618). H. B., a white female, aged forty-three.

Complaints. Dizziness and unsteadiness, deafness in the right ear.

Present Illness. In October, 1933, the patient began to have daily attacks of dizziness and

unsteadiness of gait. One month later she became completely deaf in the right ear. Three days before admission she complained of numbness around the mouth, difficulty in talking and swallowing.

Neurological Examination. The gait was unsteady. Papilledema was not present. Horizontal nystagmus occurred on lateral gaze. The right fifth, sixth, seventh, eight and ninth and the left fifth cranial nerves were involved, the right acoustic nerve showed complete nerve deafness, and the labyrinths gave no response to stimulation.

Roentgen Examination. Plain films of the skull were normal. *Ventriculograms:* Ventricular puncture was done in the *right* posterior parietal region. The ventricular system was

FIG. 9. Case VI. Drawing of a parasagittal section of the left half of the brain showing the cysts of the glomus of the choroid plexus as they appeared at necropsy.

generally dilated. There was a moderate enlargement of the *left* glomus notch which measured 25×10 mm. in the lateral horizontal views. *Impression:* Posterior fossa tumor.

Course. The patient left the hospital against advice, but was readmitted on August 23, 1934. On September 4, 1934, a large acoustic tumor was incompletely removed. The patient failed to survive the procedure.

Post-mortem Examination. A study of the brain showed the incompletely enucleated perineurial fibroblastoma with marked distortion of the brain stem. Parasagittal sections of the cerebrum through the lateral ventricles revealed an enlargement of the glomuses of the choroid plexuses due to a number of small cysts about 2 to 4 mm. in diameter, localized to these areas (Fig. 9) and more marked on the left side.

Comment. This was the only instance among the 100 cases which were reviewed in which the enlargement of the glomus notch was on the side opposite the ventricular puncture. The enlargement was not very great, the measurements being just above those assumed for the upper limits of normal. This is in contrast to the marked enlargement of several of the other cases here reported. The information obtained at the post-mortem examination of a localized collection of small simple cysts limited to the glomus of the choroid plexus explained the enlarged glomus defect in this patient's ventriculograms, and similar cysts may account for slight enlargements or those at the upper limits of normal seen in other cases.

DISCUSSION

At the time when the roentgen films of Case I were studied the large circumscribed defect in the outline of the left lateral ventricle after puncture of the atrium and injection of air was recognized to be unusual. In the encephalograms made four days later this defect was found to be definitely smaller. When the second case was seen in which the defect was even more pronounced in the ventriculogram on the side of the ventricular puncture and six days later it had likewise diminished in size, it became apparent that the defect was associated with ventricular puncture.

These two experiences led us to pay special attention to similar defects in the roentgenograms after the introduction of air by the ventricular route. When the roentgen findings in Case III were evaluated, the connection between ventricular puncture and the transitory enlargement in the region of the glomus of the choroid plexus became even clearer, so that in the fourth case we felt justified in making a diagnosis of traumatic swelling or hemorrhage of the choroid plexus or neighboring ventricular wall without subjecting the patient to encephalography.

In the first 4 patients the abnormally large defect was found at the junction of the body of the lateral ventricle with the occipital and temporal horns, in the exact situation of the normal glomus of the cho-

roid plexus. In 2 cases a puncture of one and in the other 2, of both lateral ventricles in the parieto-occipital region, had been made. In the 2 patients in whom only one ventricle had been punctured, the large filling defect was found on the side of the puncture. In the first 3 cases, in the roentgen films after the lumbar injection of air a few days later, the defect appeared much smaller. This supported the belief that there was a causative relationship between the ventricular puncture and the large size of the defect. Furthermore, the fact that defects of this size in the exact situation of the glomus of the choroid plexus were found only after *ventriculography* and had not been seen in 1,400 cases in which *encephalography* alone had been done, supported the conclusion regarding the connection between the ventricular puncture and the occurrence of the filling defect. Finally, the post-mortem demonstration of an intraventricular hematoma near the glomus of the choroid plexus following ventricular puncture in Case v furnished concrete evidence that a brain cannula may produce sufficient trauma to cause a soft tissue mass that in turn results in an obvious filling defect in the air shadow of the ventricle.

The result of the injury may vary. A slight trauma may produce edema and swelling of the glomus which subsides in a few days. On the other hand, there may be bleeding into the substance of the plexus, underneath the ependyma or into the cavity of the ventricle. Any of these lesions will produce an actual enlargement of the affected part.

While it is important to recognize the significance of a large defect in the ventricular shadow from the standpoint of diagnosis, no clinical symptoms were apparently provoked by the local injury to the brain in these 5 cases. The patient who died had a glioblastoma multiforme of the genu of the corpus callosum, which was in itself sufficient to produce death.

The enlarged ventricular defect in Case vi was due to retention cysts of the glomus of the choroid plexus as shown at necropsy. However, it was obvious from the ventriculograms alone, that the defect was not related to the ventricular puncture for the abnormal defect was contralateral to the puncture.

Similar defects may be produced by cysts of the choroid plexus (as in Case vi), benign hypertrophy of the choroid plexus, tumors of the choroid plexus or of the neighboring ventricular wall. Whenever doubt exists as to whether the defect is due to a traumatic lesion or some other cause, encephalography may be done a week later to clarify the point, for a traumatic lesion will then have largely disappeared.

SUMMARY

During puncture of the ventricles in the posterior parietal region for the introduction of air, as ordinarily done, the brain cannula may accidentally come into contact with and traumatize the glomus of the choroid plexus or a vessel in the wall of the ventricle. This may produce a hematoma or edema of the choroid plexus or the ventricular wall, which can be recognized on the roentgen films as a defect in the outline of the lower wall of the lateral ventricle situated in or near the position of the glomus. In the cases here reported:

1. The location of the abnormally large defect corresponded to the glomus of the choroid plexus.

2. The defect occurred only after ventriculography, and was on the side of the ventricular puncture when a single puncture was done.

3. At subsequent encephalography the defect was definitely decreased in size.

4. The disease from which the patient was suffering was in each case unrelated to the defect in the ventricle.

5. A defect of large size was never observed in the routine examination of the roentgen films of 1,400 cases in which air was injected only by the lumbar route.

6. A hematoma in the ventricle near the position of the glomus following ventricular puncture was demonstrable in a case at post-mortem examination.*

* For discussion see page 764.

RELIABILITY OF BRAIN TUMOR LOCALIZATION BY ROENTGEN METHODS*

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THE subject of brain tumors, their incidence, detection, localization, pathological identification, treatment, and prognosis has received the attention of many authors in recent years. Without question the introduction of pneumography by Dandy[4,5] in 1918 has played a considerable part, both directly and indirectly, in bringing about the advances achieved in this field. The imposing list of published case reports dealing with observations made upon patients studied by various pneumographic methods bears witness to the very widespread employment of these specialized roentgen procedures. The acceptance of these newer procedures as unqualified boons to suffering humanity has been by no means universal among neurologist, neurological surgeons, or even roentgenologists. Entirely aside from difference of opinion regarding the specific indications and contraindications for encephalography as opposed to ventriculography, the mortality to be expected following these examinations and their relative merits in brain tumor diagnosis, the thought has been expressed that pneumography has been and is being more energetically employed than is necessary or justifiable.[1] Sosman,[8] and Camp,[3] as well as other roentgenologists, have shown very effectively that in many cases reliable localizing signs of intracranial tumor can be demonstrated by the detailed search of first quality skull films without recourse to the more spectacular air injection studies.

Published figures regarding the efficacy of clinical neurological examination in localizing intracranial tumors without the assistance of roentgenology range between 47 and 84.6 per cent, the lower figure applying to tumors of the cerebrum, the higher to tumors about the sella turcica.[7] Roentgenograms made without previous air injection are variously estimated to be of effective localizing value in their own right in 15 to 37 per cent of brain tumor cases.[5,6] Bailey[2] in his book "Intracranial Tumors" published in 1933, urges neurologists to devote their chief attention to the preoperative diagnosis of the pathological type of tumors, confident that upon the basis of clinical symptomatology alone 80 to 85 per cent of intracranial tumors can be correctly localized, and believing that air injection roentgen studies greatly facilitate localization of the remaining 15 to 20 per cent.

In attempting to analyze our own experiences with brain tumors we have found difficulty in comparing them with those of others, largely because of the numerous and varied ways in which figures have been presented. Much as we should like to review all cases in which we have been called upon to examine the cranial vault and its contents, by which means we might hope to bring to light all of our diagnostic errors both positive and negative, this is not feasible. The inevitable failure of many cases to yield ultimate conclusive diagnostic confirmation as well as our own inability to gather comparable information upon all patients from existing records effectively prevents a study of this sort. Furthermore, it seems unwise to attempt to draw conclusions from case experiences where intracranial lesions other than primary neoplasm were proved at operation or autopsy, for the inclusion of those cases cannot uncover all errors of commission and merely serves to confuse the issue. By gathering together the available records of all cases in which primary intracranial neoplasm

* From the Department of Roentgenology, University of Michigan, Ann Arbor, Mich. Read at the Thirty-fifth Annual Meeting, American Roentgen Ray Society, Pittsburgh, Pa., Sept. 25–28, 1934.

was found upon operation or autopsy at the University Hospital during the three years ending July 1, 1934, it has been possible at least to evaluate the accuracy of the preoperative observations in every case where pathological tumor type and actual location within the brain has been established beyond question. Those situations where operation was performed without yielding biopsy material and in which no subsequent autopsy was obtained have been excluded.

Using mechanical card sorting apparatus, tabulating cards of the usual commercial type were set up to carry preoperative diagnostic details, surgical and pathological findings, and such information as the name, number, sex and age of the patient. All of these data were coded and transferred to the cards by means of a punching machine to permit mechanical sorting. Cards were prepared for all cases recruited from the files of roentgenology, neurology, neurosurgery, and neuropathology which seemed to have a bearing upon the problems in hand, and then it was possible with great rapidity and accuracy to select for study individual groups of cases arranged according to any criteria one might choose. It may be said in passing that mechanical sorting equipment presents enormous possibilities in the field of medical education and investigation as yet but very meagerly exploited.

One hundred and ninety cases of proved primary intracranial neoplasm so studied were readily arranged according to Bailey's classification of pathological type in order of actual anatomical location from frontal lobe to cerebellum within each division. In addition, age and statements regarding localization by clinical examination and various roentgen procedures were listed (Table I). A lengthy tabulation of this sort does not permit one to quickly assimilate the information it contains, valuable though it is as an accurate record of detailed information. With the greatest of ease, however, the material was arranged to show numerical case distribution according to tumor type devoid of all other considerations (Table II). This table shows that in this series 58.4 per cent were identified as encephalic tumors, 23.7 per cent tumors of covering cells, 12.1 per cent hypophyseal tumors, 3.2 per cent dysembryomas and 2.6 per cent vascular tumors, closely paralleling the distribution reported by Cushing in his very large series in 1932. The data, when rearranged in order to observe age distribution, showed no serious discrepancy from the already known age incidence tendencies of various tumor types.

Turning to the matter of accuracy of diagnosis, it was possible by a very simple manipulation to answer this question: "In how many cases of this series was it possible on the basis of neurological examination alone to predict the location of the tumor correctly?" The recorded opinion of the Department of Neurology as to tumor site had been coded by perforations in a particular column of every card. This code grouped opinions as follows: (1) no localizing signs; (2) erroneous localization in the light of subsequent findings; (3) vague localization, and (4) correct localization. By sorting for the particular position on all cards allocated to this last statement one process of the sorter threw out 98 cards leaving 92 in which that particular position had not been perforated, or in other words, showing that neurological examination alone had been sufficient in 51.6 per cent of all cases. By sorting for the corresponding perforations representing correct localization by routine roentgen studies of the skull a second run through the sorter threw out 24 cards, leaving 68 tumors which by combined efforts of the neurologist and roentgenologist had not been accurately localized. Turning to the column representing encephalographic examination the machine plucked out an additional 9 cards representing as many cases in which by joint effort neurology and roentgenology had successfully located the tumor. The original pack of 190 had by now dwindled to 59, representing

TABLE I

TUMOR TYPES AND LOCALIZATION

No.	Tumor Type	Age	Sex	Neurological Localization	Routine Skull Localization	Encephalogram Localization	Ventriculogram Localization	Operation or Autopsy Localization
	ENCEPHALIC TUMORS							
	Gliomas							
1	Glioma unclassified	50	M	Correct	Indeterminate	Not done	Not done	Right cerebrum
2		35	F	Correct	Indeterminate	Not done	Not done	Left frontal
3		33	F	Correct	Negative	Not done	Correct	Left cerebellar
4	Glioblastoma multiforme	40	M	Correct	Not done	Not done	Not done	Right frontal
5		18	F	Correct	Indeterminate	Not done	Not done	Right frontal
6		54	F	Indeterminate	Indeterminate	Not done	Correct	Right forntal
7		57	M	Correct	Not done	Not done	Not done	Right frontal
8		20	M	Indeterminate	Indeterminate	Not done	Correct	Right frontal
9		21	M	Indeterminate	Negative	Not done	Correct	Left frontal
10		16	M	Correct	Not done	Not done	Correct	Left frontal
11		49	M	Indeterminate	Not done	Not done	Correct	Left frontal
12		52	M	Wrong	Negative	Not done	Correct	Left fronto-parietal
13		41	F	Correct	Negative	Correct	Not done	Left fronto-parietal
14		60	F	Correct	Negative	Not done	Not done	Right parietal
15		50	M	Correct	Negative	Not done	Correct	Right parietal
16		45	F	Indeterminate	Negative	Not done	Correct	Right parietal
17		43	F	Correct	Negative	Not done	Not done	Left parietal
18		40	M	Indeterminate	Negative	Not done	Correct	Left parietal
19		13	F	Indeterminate	Correct	Not done	Not done	Left parietal
20		33	F	Indeterminate	Negative	Not done	Correct	Right parieto-temporal
21		29	M	Correct	Indeterminate	Not done	Not done	Right parieto-temporal
22		42	F	Correct	Indeterminate	Not done	Not done	Right parieto-temporal
23		43	F	Indeterminate	Negative	Not done	Correct	Right temporal
24		32	M	Correct	Negative	Not done	Not done	Left temporal
25		37	F	Indeterminate	Negative	Not done	Correct	Left temporal
26		48	M	Correct	Negative	Not done	Not done	Right parieto-occipital
27		51	F	Indeterminate	Wrong	Not done	Not done	Right parieto-occipital
28		38	F	Indeterminate	Indeterminate	Not done	Correct	Left parieto-occipital
29		36	M	Indeterminate	Not done	Not done	Correct	Right occipital
30		27	M	Indeterminate	Negative	Not done	Correct	Pineal region
31		31	F	Indeterminate	Indeterminate	Not done	Correct	Pineal region
32		10	F	Indeterminate	Correct	Not done	Correct	Left cerebellar
33	Spongioblastoma polare	44	M	Indeterminate	Not done	Not done	Correct	Right fronto-parietal
34		20	F	Wrong	Indeterminate	Not done	Correct	Right parietal
35		15	M	Correct	Indeterminate	Not done	Not done	Left optic nerve
36		6	M	Correct	Correct	Not done	Not done	Left optic nerve
37		60	F	Correct	Negative	Not done	Not done	Right acoustic
38	Ependymoma	11	F	Wrong	Negative	Not done	Correct	Left frontal
39		13	F	Indeterminate	Not done	Not done	Correct	Left frontal
40		6	M	Wrong	Correct	Not done	Not done	Left frontal
41		22	M	Indeterminate	Not done	Not done	Correct	Right temporal
42		31	M	Negative	Correct	Not done	Not done	Right temporal
43		34	M	Correct	Indeterminate	Not done	Indeterminate	Third ventricle
44		41	F	Correct	Indeterminate	Not done	Not done	Fourth ventricle
45		3	F	Correct	Indeterminate	Not done	Not done	Fourth ventricle
46		25	M	Indeterminate	Indeterminate	Not done	Correct	Right parietal
47		44	F	Wrong	Negative	Not done	Correct	Pineal region
48		26	M	Wrong	Indeterminate	Not done	Wrong	Pineal region
49	Astrocytoma	38	F	Indeterminate	Wrong	Not done	Correct	Widespread
50		50	F	Wrong	Indeterminate	Not done	Not done	Widespread
51		55	M	Indeterminate	Negative	Not done	Correct	Right frontal
52		14	F	Correct	Indeterminate	Not done	Not done	Right frontal
53		31	M	Wrong	Negative	Correct	Not done	Right frontal
54		46	M	Wrong	Negative	Indeterminate	Correct	Right frontal
55		55	F	Indeterminate	Not done	Not done	Correct	Right frontal
56		38	F	Correct	Negative	Not done	Not done	Left frontal
57		39	F	Correct	Negative	Not done	Not done	Left frontal
58		40	M	Indeterminate	Correct	Correct	Not done	Left frontal
59		34	M	Wrong	Indeterminate	Not done	Correct	Left frontal
60		29	M	Wrong	Negative	Not done	Not done	Right fronto-parietal
61		24	M	Correct	Negative	Not done	Not done	Right fronto-parietal
62		42	M	Indeterminate	Negative	Not done	Correct	Right fronto-parietal
63		14	M	Indeterminate	Correct	Not done	Not done	Right fronto-parietal
64		40	M	Indeterminate	Negative	Correct	Not done	Left fronto-parietal
65		42	M	Correct	Indeterminate	Not done	Not done	Right parietal
66		39	M	Correct	Negative	Correct	Not done	Left parietal
67		52	M	Correct	Negative	Not done	Not done	Left parietal

TABLE I—(*Continued*)

No.	Tumor Type	Age	Sex	Neurological Localization	Routine Skull Localization	Encephalogram Localization	Ventriculogram Localization	Operation or Autopsy Localization
68		47	M	Indeterminate	Correct	Not done	Not done	Left parietal
69		33	M	Indeterminate	Correct	Not done	Not done	Right parieto-temporal
70		29	F	Correct	Indeterminate	Not done	Not done	Right parieto-temporal
71		14	F	Correct	Not done	Indeterminate	Not done	Left parieto-temporal
72		44	M	Correct	Negative	Not done	Correct	Right temporal
73		30	M	Indeterminate	Indeterminate	Indeterminate	Correct	Right temporal
74		39	M	Indeterminate	Negative	Correct	Correct	Right temporal
75		26	F	Indeterminate	Negative	Correct	Not done	Left temporal
76		32	M	Indeterminate	Negative	Correct	Correct	Left temporal
77		63	M	Indeterminate	Negative	Not done	Correct	Left temporal
78		43	M	Correct	Indeterminate	Not done	Not done	Left temporal
79		32	M	Indeterminate	Negative	Not done	Not done	Rt. temp-parieto-occip.
80		23	M	Indeterminate	Negative	Not done	Correct	Lt. temp-parieto-occip.
81		25	M	Indeterminate	Indeterminate	Correct	Correct	Lt temp-parieto-occip.
82		43	M	Correct	Not done	Not done	Not done	Right parieto-occipital
83		53	M	Correct	Negative	Indeterminate	Not done	Right lateral ventricle
84		16	M	Correct	Negative	Not done	Not done	Rt cerebellopontine angle
85		7	F	Correct	Negative	Not done	Not done	Pons
86		9	M	Correct	Indeterminate	Not done	Not done	Posterior fossa
87		5	M	Correct	Not done	Not done	Not done	Right cerebellar
88		11	F	Correct	Indeterminate	Not done	Not done	Right cerebellar
89		25	F	Indeterminate	Indeterminate	Not done	Correct	Right cerebellar
90		16	M	Correct	Negative	Not done	Not done	Left cerebellar
91		38	F	Indeterminate	Negative	Not done	Correct	Left cerebellar
92		23	F	Wrong	Not done	Not done	Correct	Left cerebellar
93		10	M	Correct	Correct	Not done	Not done	Left cerebellar
94		9	F	Correct	Correct	Not done	Not done	Left cerebellar
95		6	M	Correct	Not done	Not done	Correct	Midline cerebellar
96		16	F	Wrong	Indeterminate	Not done	Correct	Midline cerebellar
97		17	F	Wrong	Indeterminate	Not done	Correct	Midline cerebellar
98	Oligodendroglioma	43	F	Correct	Negative	Not done	Not done	Left frontal
99		58	M	Correct	Correct	Not done	Not done	Left frontal
100		41	M	Correct	Negative	Indeterminate	Not done	Right fronto-parietal
101		18	F	Indeterminate	Correct	Not done	Not done	Left parietal
	Glioneuromas							
102	Medulloblastoma	1	F	Indeterminate	Not done	Not done	Not done	Left cerebrum
103		47	M	Indeterminate	Not done	Not done	Correct	Left frontal
104		30	F	Correct	Negative	Not done	Not done	Pons
105		6	F	Correct	Not done	Not done	Not done	Right cerebellar
106		2	M	Indeterminate	Not done	Not done	Correct	Right cerebellar
107		4	F	Correct	Indeterminate	Not done	Not done	Right cerebellar
108		10	M	Correct	Negative	Not done	Not done	Left cerebellar
109		8	F	Correct	Indeterminate	Not done	Not done	Left cerebellar
110		20	M	Indeterminate	Negative	Not done	Correct	Midline cerebellar
111		3	M	Indeterminate	Indeterminate	Not done	Correct	Midline cerebellar
	TUMORS OF COVERING CELLS OF NERVOUS SYSTEM							
	Meningeal tumors							
112	Meningothelioma	39	M	Correct	Negative	Correct	Not done	Right frontal
113		50	F	Correct	Correct	Not done	Not done	Right frontal
114		58	F	Correct	Indeterminate	Not done	Not done	Right fronto-temporal
115		32	M	Indeterminate	Negative	Correct	Not done	Right fronto-parietal
116		59	M	Correct	Negative	Not done	Not done	Right parietal
117		38	F	Correct	Indeterminate	Not done	Not done	Right parietal
118		24	M	Wrong	Negative	Correct	Not done	Left parietal
119		54	M	Indeterminate	Negative	Correct	Not done	Left parietal
120		55	F	Wrong	Correct	Not done	Correct	Left parieto-temporal
121		32	F	Correct	Indeterminate	Not done	Not done	Right temporo-sphenoidal
122		47	M	Correct	Correct	Not done	Not done	Right acoustic
123		53	M	Correct	Negative	Not done	Not done	Lt. cerebellopontine angle
124		57	F	Correct	Correct	Not done	Not done	Lt. cerebellopontine angle
125		46	M	Wrong	Wrong	Not done	Correct	Posterior fossa
126		43	M	Correct	Correct	Correct	Not done	Right sphenoid ridge
127		52	F	Indeterminate	Correct	Not done	Correct	Left sphenoid ridge
128		22	F	Indeterminate	Indeterminate	Not done	Correct	Left sphenoid ridge
129		49	F	Correct	Negative	Not done	Correct	Cribriform plate
130		54	M	Correct	Correct	Not done	Not done	Cribriform plate
131		33	F	Correct	Correct	Not done	Not done	Left mid fossa

TABLE I—(*continued*)

No.	Tumor Type	Age	Sex	Neurological Localization	Routine Skull Localization	Encephalogram Localization	Ventriculogram Localization	Operation or Autopsy Localization
132	Fibroblastoma	18	M	Correct	Indeterminate	Not done	Not done	Right frontal
133		20	F	Correct	Correct	Not done	Not done	Right acoustic
134	Sarcoma	66	M	Correct	Indeterminate	Not done	Correct	Right frontal
135		25	F	Correct	Correct	Not done	Not done	Left frontal
136		2	F	Correct	Correct	Not done	Not done	Left frontal
137		38	F	Indeterminate	Correct	Correct	Correct	Left fronto-parietal
138		28	F	Correct	Correct	Not done	Not done	Right parietal
139		46	M	Indeterminate	Negative	Not done	Correct	Right temporal
140		48	M	Correct	Indeterminate	Not done	Indeterminate	Right parieto-occipital
141		3	F	Correct	Indeterminate	Not done	Not done	Left cerebellopontine angle
142		13	M	Indeterminate	Indeterminate	Not done	Not done	Left mid fossa
	Sheath tumors							
143	Neurinoma	3	F	Indeterminate	Indeterminate	Not done	Correct	Optic chiasm
144		36	M	Correct	Negative	Not done	Not done	Right acoustic
145		38	F	Correct	Negative	Not done	Not done	Right acoustic
146		27	F	Correct	Correct	Not done	Not done	Right acoustic
147		63	F	Indeterminate	Correct	Not done	Not done	Right acoustic
148		52	F	Indeterminate	Correct	Not done	Not done	Right acoustic
149		46	F	Correct	Indeterminate	Not done	Indeterminate	Right acoustic
150		20	F	Correct	Negative	Not done	Not done	Left acoustic
151		23	M	Correct	Correct	Not done	Not done	Left acoustic
152		50	M	Correct	Correct	Not done	Not done	Left acoustic
153		16	F	Correct	Indeterminate	Not done	Not done	Bilateral acoustic
154		43	F	Indeterminate	Negative	Not done	Indeterminate	Rt. cerebellopontine angle
155		43	M	Correct	Negative	Not done	Not done	Rt. cerebellopontine angle
156		21	F	Indeterminate	Correct	Not done	Not done	Left mid fossa
	HYPOPHYSIAL TUMORS							
	Adenoma							
157	Undifferentiated	22	M	Correct	Not done	Not done	Not done	Intrasellar
158		47	F	Correct	Not done	Not done	Not done	Intrasellar
159		20	F	Correct	Correct	Not done	Not done	Intrasellar
160		62	F	Indeterminate	Correct	Not done	Not done	Intrasellar
161	Chromophobe	26	M	Indeterminate	Indeterminate	Not done	Not done	Left fronto-temporal
162		46	M	Correct	Correct	Not done	Not done	Intrasellar
163		46	F	Correct	Correct	Not done	Not done	Intrasellar
164		38	F	Correct	Not done	Not done	Not done	Intrasellar
165		23	M	Correct	Correct	Not done	Not done	Intrasellar
166		19	F	Correct	Correct	Not done	Not done	Intrasellar
167		41	F	Correct	Correct	Not done	Not done	Intrasellar
168		37	F	Indeterminate	Correct	Not done	Not done	Intrasellar
169		23	M	Indeterminate	Correct	Not done	Not done	Intrasellar
170		32	F	Correct	Indeterminate	Not done	Not done	Intrasellar
171		52	M	Correct	Correct	Not done	Not done	Intrasellar
172	Craniopharyngioma	54	M	Indeterminate	Correct	Correct	Indeterminate	Intrasellar
173		8	M	Indeterminate	Correct	Not done	Not done	Intrasellar
174		41	M	Indeterminate	Correct	Not done	Not done	Intra and suprasellar
175		11	M	Correct	Correct	Not done	Not done	Intrasellar
176		22	F	Correct	Correct	Not done	Not done	Intra and suprasellar
177		4	F	Indeterminate	Correct	Not done	Not done	Intra and suprasellar
178		8	M	Indeterminate	Correct	Not done	Not done	Intra and suprasellar
179		24	M	Indeterminate	Correct	Not done	Not done	Intra and suprasellar
	DYSEMBRYOMAS							
180	Teratoid cyst	22	M	Correct	Indeterminate	Not done	Correct	Pineal region
181	Pearly tumor	43	F	Indeterminate	Indeterminate	Not done	Correct	Fourth ventricle
182	Chordoma	42	F	Wrong	Negative	Not done	Not done	Pons
183		19	F	Correct	Not done	Not done	Not done	Left mid fossa
184	Pinealoma	21	M	Wrong	Negative	Not done	Correct	Pineal region
185		14	M	Indeterminate	Not done	Not done	Correct	Pineal region
	VASCULAR TUMORS							
	Hemangioblastoma							
186	(Lindau's type)	55	F	Correct	Negative	Not done	Not done	Lt. cerebellopontine angle
187		25	F	Indeterminate	Negative	Not done	Correct	Posterior fossa
188		53	M	Indeterminate	Indeterminate	Not done	Correct	Posterior fossa
189		20	F	Correct	Negative	Not done	Not done	Left cerebellar
190		49	F	Indeterminate	Indeterminate	Not done	Correct	Left cerebellar

cases which still defied preoperative efforts at localization. The neurological surgeon together with the roentgenologist had now tried ventriculography, and the sorting

Table II

TUMORS CLASSIFIED ACCORDING TO BAILEY

	No. Cases	Total	Per Cent
Encephalic Tumors			
Gliomas			
Glioma unclassified	3		
Glioblastoma multiforme	29		
Spongioblastoma polare	5		
Ependymoma	11		
Neuroepithelioma	0		
Astroblastoma	0		
Astrocytoma	49		
Oligodendroglioma	4		
Glioneuromas			
Medulloblastoma	10		
Ganglioneuroma	0	111	58.4
Tumors of Covering Cells of Nervous System			
Meningeal tumors			
Meningothelioma	20		
Fibroblastoma	2		
Osteoma	0		
Lipoma	0		
Melanoblastoma	0		
Hemangioblastoma	0		
Sarcoma	9		
Sheath tumors			
Neurinoma	14	45	23.7
Hypophysial Tumors			
Adenomas			
Undifferentiated	4		
Eosinophile	0		
Chromophobe	11		
Craniopharyngioma	8	23	12.1
Dysembryomas			
Teratoid cysts	1		
Pearly tumors	1		
Chordomas	2		
Pinealomas	2		
Papillomas	0	6	3.2
Vascular Tumors			
Hemangioblastoma (Lindau's type)	5		
Angioma racemosum	0		
Capillary telangiectasis	0	5	2.6

machine bore witness to the measure of success they achieved by removing 49 cards. Quite naturally the remaining 10 cards were examined with interest to learn, if possible, by what means or for what reason the 10 cases thus represented had escaped the meshes of the diagnostic dragnet. Three had died without air injection studies of any sort and without operation to be verified only by autopsy. Neurological localizations were indeterminate in 5 of these cases and erroneous in 5. Routine roentgen studies of the skull were used in each case, with the exception of one. One tumor incorrectly localized as a frontal lobe meningothelioma on the basis of hyperostosis of the inner table of the skull proved at operation to be an intracortical glioma in the parieto-occipital region. The remaining studies of this type were of no localizing value. Pneumography was used in only 2 of these 10 cases. Ventriculography, the procedure employed, gave results indeterminate in the one instance, misleading in the other. In reviewing these 10 cases in which correct localization was not accomplished, except by surgical or pathological means, one gains the impression that the more frequent use of pneumography might have increased diagnostic accuracy. Chart 1 shows not only this information but also the number of times various roentgen studies were advantageously employed when they were not the sole stop-gap against error or non-recognition.

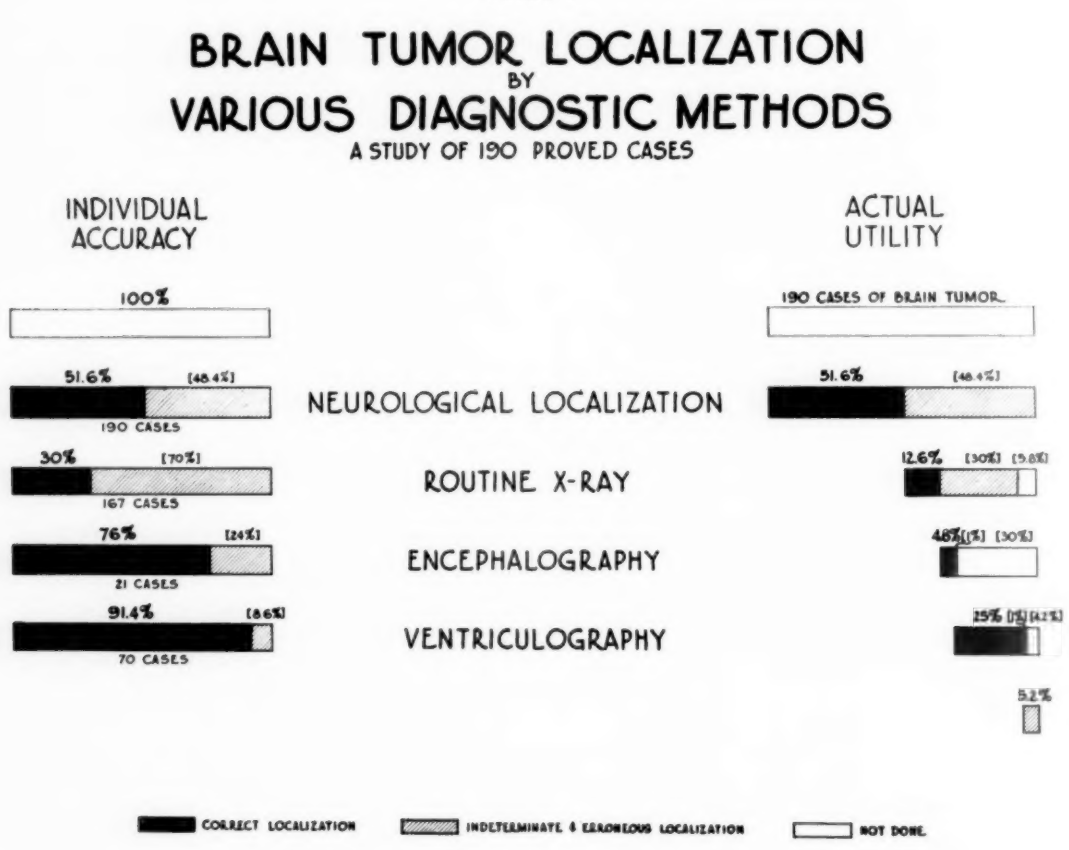
As a result of this particular investigation it is seen that, relying solely upon clinical information, 51.6 per cent of tumors were correctly localized; routine skull films in their own right were 12.6 per cent effective where neurological methods had failed; encephalography unassisted, salvaged 4.8 per cent and ventriculography, reserved for cases resisting simpler forms of examination, made possible the correct diagnosis of 25.8 per cent. Only 5.2 per cent of this group of proved tumors eluded correct preoperative recognition as to site and, as we have seen in the majority of these, ample opportunity for study was impossible. Percentage figures, at first glance far more flattering to the roentgenologist, are obtained when one computes accuracy for the various roentgen methods only upon

the cases in which they were employed. From the viewpoint of actual clinical utility, however, the figures as quoted are much more significant.

We have no desire to advocate the indiscriminate or more widespread employment of pneumography in the examination of suspected brain tumor patients; on the contrary, we are delighted to find in reviewing our activities during the past three years that our own employment of these procedures appears to have been justified in view of the fact that patients were not unnecessary subjected to such studies. We view with interest the remarks of Adson[1] regarding his expressed opinion that even though ventriculography may result in the localization of a tumor unrecognizable by any other means that information may actually result in needless operation for a lesion impossible of successful removal. As roentgenologists it is scarcely fitting and surely unnecessary to confirm or refute that opinion—sufficient to know that ventriculography constitutes a tool useful in this work when others fail and properly to be used only under those conditions.

It is reassuring to find that from routine skull films prepared with the greatest of care and precision at our command and so planned as to render visible the numerous and often minute telltale signs of brain tumor it has been possible to successfully augment the efforts of the neurologist in a comfortable percentage of instances. In retrospect it has been possible as the result of experience with pneumography to reassure ourselves as to the reliability of observations made in routine skull films. It is gratifying, as a result of an investigation of this sort, to emerge with convincing

CHART I



proof that brain tumor diagnosis is properly a group effort—neurologist, roentgenologist, neurological surgeon, and pathologist, each contributing valuable assistance in the accomplishment of a genuinely worth while task often perplexing and seldom simple.*

* For discussion see page 764.

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THE RESPONSIBILITY OF THE ROENTGENOLOGIST IN THE DETECTION OF INTRACRANIAL TUMORS*

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THE subject of intracranial tumors is generally regarded as outside the province of the average roentgenologist. It is believed that the roentgenologic detection of such tumors must be left to those roentgenologists associated with the neurosurgical clinics of the larger cities. This, no doubt, accounts for the lack of interest and knowledge of this subject on the part of most roentgenologists. While it is true that the final diagnosis of intracranial neoplasms is usually made in institutions possessed of a well organized neurological service and localization is often dependent upon either encephalography or ventriculography, nevertheless it must be remembered that patients with brain tumor are first seen by the general practitioner. The local roentgenologist is often called upon to lend his aid in eliciting the cause of the symptoms of such patients. It is as true of growths within the intracranial cavity as elsewhere in the body that best results can be expected from surgery the earlier the detection of the lesion. It is essential, therefore, that the patient with a brain tumor receive proper treatment at the earliest possible moment. It thus becomes necessary that the physicians to whom such patients first apply for medical attention be sufficiently alert and possessed of such knowledge as to permit them to recognize the early manifestations of intracranial neoplasms. Since the roentgen examination is so often of inestimable value in the detection of such lesions, all general roentgenologists must share the responsibility presented by this class of patient.

Many roentgenologists are at a loss to know what to look for in their search for evidence of intracranial tumors. As a matter of fact, there are only a few cardinal manifestations that need be considered. It is not necessary that the roentgenologist make a positive diagnosis of brain tumor and it is unlikely that he will be able to do so in the early case. He should, however, recognize those signs suggestive of such a lesion so that further studies can be carried out. It might be well to adopt a plan such as has been so ardently advocated by Bloodgood in recent years for the diagnosis of bone tumors. Any roentgenograms of the head of a patient whose symptoms could be due to a brain tumor which show evidence suggestive of such a lesion might be sent to some roentgenologist who has had considerable experience in this particular field for an opinion. Such a plan would, in many instances, lead to a much earlier diagnosis and would directly contribute to a higher percentage of cures in this class of patient.

THE TECHNIQUE OF ROENTGENOGRAPHY OF THE HEAD

Before discussing the manifestations of intracranial tumors it would be well to consider briefly the technique of roentgenography of the head. There is considerable variation in the technique employed by various roentgenologists. While there need be no hard and fast rules, there are three prime requisites for satisfactory results. To be of diagnostic value, the roentgenograms should possess the greatest possible detail. For this purpose, the use of the Potter-Bucky diaphragm is an absolute essential. Secondly, a fine focus tube is indispensable. Satisfactory detail cannot be obtained with a general roentgenographic tube used for all purposes. The third requisite is proper positioning of the head. Too little care is exercised by the average

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technician in securing accurate positions in head roentgenography. In lateral views, one must be certain that the head is in a true lateral position. This cannot be attained in a haphazard manner. All bilateral structures must be superimposed upon the resultant roentgenogram. It is surprising the strange and confusing effects which may be produced by faulty positions. The same remarks hold true for all other views of the head which may be employed. The most common technical error observed in roentgenograms sent us for an opinion has been in the matter of positioning. The importance of this factor cannot be overemphasized.

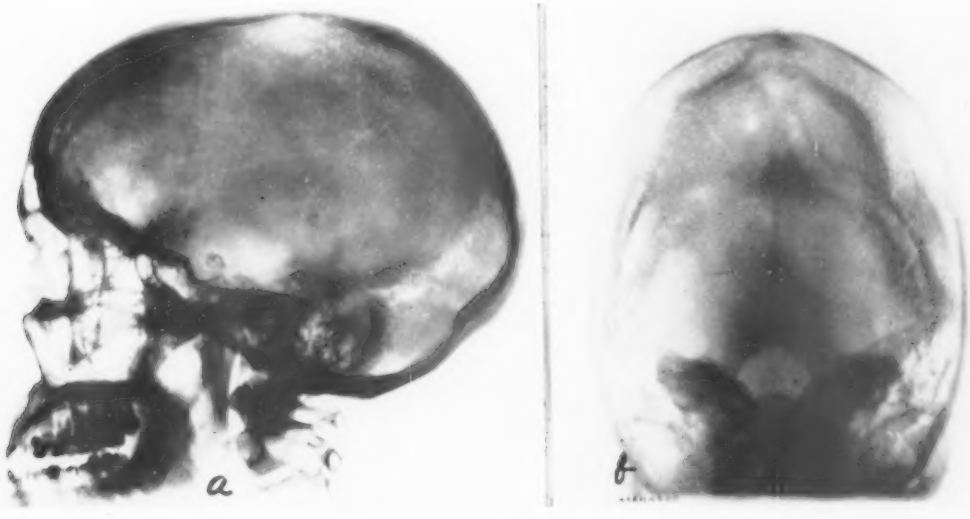

Fig. 1. *a*. Lateral view of the skull. *b*. Occipital view. These are the only views required in the majority of cases of intracranial tumor, since most of the roentgen manifestations can be detected in these exposures. Note the normally placed calcified pineal body in both views.

The examination of the head need not in the average case be an elaborate affair. Especially in these days of rigid economy, the minimum number of films should be employed. As a routine procedure in our ward and dispensary patients only two views are made, a lateral and an occipital exposure (Fig. 1). The lateral view is by far the most valuable, as most manifestations of brain tumor will be detected in this view. The occipital exposure is of value in detecting lateral shifts of a calcified pineal body, erosions of the petrous ridge and will serve to lateralize shadows seen in the lateral view. Fig. 1, *b* illustrates the occipital view, so-called because in this exposure an excellent view is obtained of the entire occipital bone. It is sometimes referred to as the "Towne plate" having been described some years ago by E. B. Towne.[16] While it is an anteroposterior exposure of the skull, this designation should be reserved for the view in which the central ray is directed along the long axis of the head. The occipital view is also sometimes erroneously referred to as the base view, which will be subsequently described.

While the two views already referred to are sufficient in many instances, the number of films employed should be made to suit the individual case. The history will often suggest a lesion in a certain locality, which may best be shown by some exposure other than the lateral or the occipital view. Such an exposure should be made in addition. If suggestive evidence of an intracranial lesion is found in either the lateral or occipital projection, additional views should be made in order to more definitely show the pathological changes or to bring forth additional information. Stereoscopic films are a matter of individual preference.

We have given up the routine use of stereoscopy in examinations of the head, using such films only in exceptional cases. In private practice, the examination must be somewhat more elaborate as it is not always practical or advisable to have the patient return for additional exposures. Here again the number of films and the views to be employed are a matter of preference with the individual roentgenologist.

WHAT TO LOOK FOR

What to look for can best be considered under the various headings as shown in Table 1, which indicates the relative frequency of the various roentgen manifestations of intracranial tumors as compiled from a recent analysis of 446 verified cases.

TABLE I

THE INCIDENCE OF THE VARIOUS ROENTGEN MANIFESTATIONS OF INTRACRANIAL TUMOR OCCURRING IN A SERIES OF 446 VERIFIED CASES

	Per cent
1. Deformation of the sella turcica	64.6
2. Convolutional atrophy	8.8
3. Calcification of the tumor	6.5
4. Widening of the sutures	4.6
5. Local bone erosion	2.9
6. Local hyperostosis	1.8
7. Lateral shift of the pineal body	1.8
8. Widened diploic channels	0.2

Deformation of the Sella Turcica. By far the most frequent finding in brain tumor is deformation of the sella turcica. Approximately two-thirds of all cases will show some alteration in this structure. Since few conditions other than intracranial neoplasms affect the sella, changes in this structure are of considerable diagnostic value. The type of deformity produced by various lesions has been described in previous reports.[6,7] The deformation resulting from a pituitary tumor is well known and easily recognized. It is the only sellar deformity that can be regarded as at all pathognomonic. The unilateral erosion of the sella turcica occurring in tumors in the middle cranial fossa is quite characteristic in many instances and when correlated with the clinical aspects of the case will often enable one to indicate the approximate location of the lesion. It is to be remembered that tumors need not be in the immediate vicinity of the sella in order to change its appearance. Under favorable circumstances, lesions in any part of the intracranial cavity may affect this structure. While deformation of the sella turcica is an extremely important sign as regards the presence of an intracranial tumor, it is of value in the localization of such a lesion in slightly less than 50 per cent of cases. The importance of sellar deformations cannot be overemphasized. One must be extremely alert to detect the minor changes which are sometimes of considerable clinical significance. Erosion of the sella is the cardinal manifestation of its abnormality. Bone erosion is always denoted by lack of detail. Any sella which does not possess the same detail as the surrounding osseous structures is abnormal regardless of its size or shape. It is in the interpretation of roentgenograms of the sella turcica that the importance of accurate positioning of the head manifests itself. Anything but a true lateral projection of the sella will often result in bizarre appearances which may readily simulate changes found as the result of brain tumors. Pancoast[10] has recently emphasized the errors which may occur in the interpretation of roentgenograms of the sella turcica in an excellent article on this subject.

Calcification of Brain Tumors. The most positive of all roentgen signs of an intracranial neoplasm is calcification of the tumor. Unfortunately this is not of common occurrence. As indicated in Table 1, calcification was found in only 6.5 per cent of the series of cases analyzed. Such calcifications occur most frequently in gliomas (Fig. 2, *b*). They may be found in any portion of the intracranial cavity although they are seldom seen below the tentorium. A common site for neoplastic calcification is just above the sella turcica. In the majority of instances, this denotes a craniopharyngioma (hypophyseal duct tumor) as

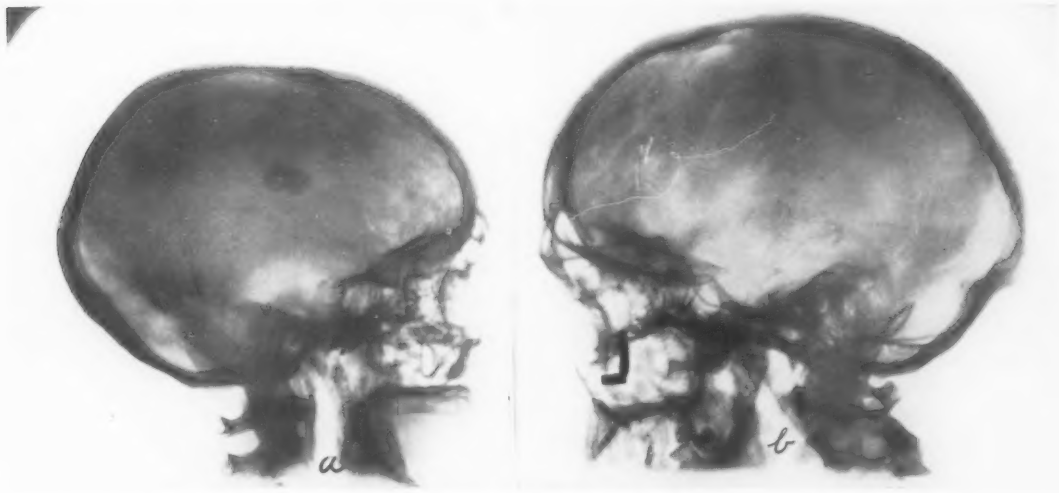

Fig. 2. Two calcified intracranial lesions. *a*. Calcified hematoma in the left parietal lobe. *b*. Calcification within a glioma in the right temporoparietal region.

indicated by McKenzie and Sosman,[9] who found calcification in 70 per cent of their series of cases. The type of calcification occurring in intracranial tumors may possess some significance as regards the histological nature of the growth, as reported by Schwartz.[12] Tumor calcification may be extremely faint and can be readily overlooked unless roentgenograms of excellent detail are produced.

Care must be taken in the interpretation of certain physiological calcifications which are of frequent occurrence. Calcification of the pineal body is now such a common observation that it is not likely to be misinterpreted. Tumors of the pineal body are relatively uncommon and calcification within them is so rare that it need be given little consideration. Of more significance is the occasional calcification occurring in the choroid plexus (Fig. 3). This possibility must be kept constantly in mind. The location of such calcifications in the posterior parietal region as seen in the lateral view and the fact that such shadows are usually bilateral should insure the correct inter-

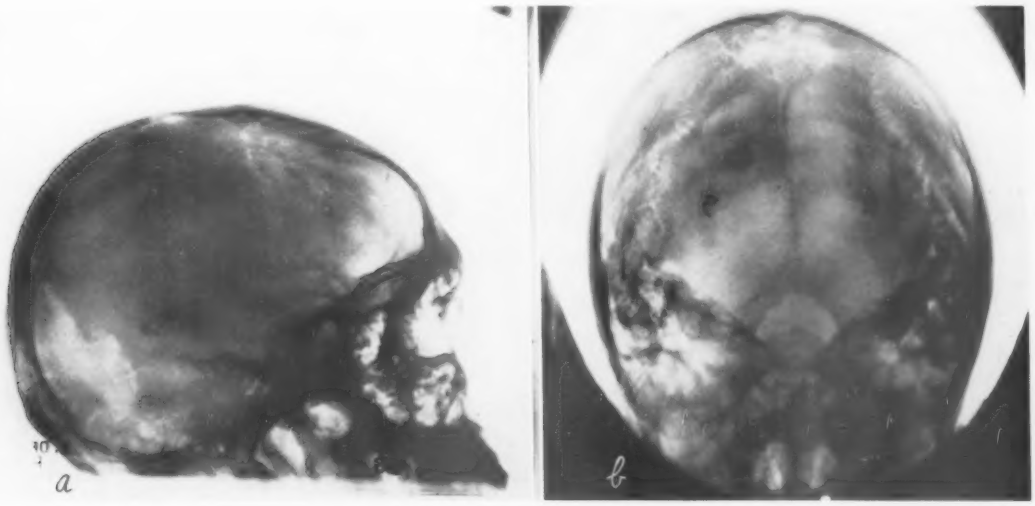

Fig. 3. Bilateral calcification of the choroid plexus seen in both the lateral and occipital views.

pretation in the majority of instances. In cases of unilateral calcification, the problem is somewhat more difficult, but correlation with the clinical data, which must never be neglected, may aid in arriving at the correct conclusion. A unilateral calcification may occasionally be mistaken for a displaced pineal body. Obviously this is a serious error. Fortunately, calcification of the choroid is almost always larger in size than is ever seen in the pineal body so that the two are not likely to be confused. Ossified plaques in the falx cerebri are of frequent occurrence. Their midline position and linear contour, as seen in anteroposterior projections, render them readily recognized. Such plaques are much less frequent in the tentorium and meninges. Calcified Pacchionian bodies usually give rise to no difficulty because of their size and location on either side of the sagittal suture in the parietal region. The shadows frequently seen about the sella turcica due to true ossification of the various dural attachments should not be mistaken for pathological calcifications. Such ossifications are to be encountered chiefly in the petro-clinoid ligaments, the clivus and the diaphragma sellae. They have no clinical significance. Not infrequently in elderly individuals sclerotic changes will be observed in the internal carotid artery as it passes alongside of the sella turcica. This will usually present itself as two parallel lines crossing the pituitary fossa. Familiarity with this appearance will prevent an erroneous interpretation. Very occasionally such sclerotic changes may aid in the recognition of an aneurysm of the carotid artery. In this connection, it is well to call attention to the fact that in patients with hypertension it is not uncommon to find evidence of erosion of the sella turcica. Such changes are due to transmitted pulsations from the vessels comprising the circle of Willis and should not be attributed to an intracranial tumor unless substantiated by rather positive clinical evidence.

Pathological in nature but not to be confused with neoplasms are the calcifications occasionally seen in the meninges. Such shadows are located peripherally and are often associated with a history of trauma, the calcification having occurred in a subdural hematoma. According to Camp,[1] calcified hematomata (Fig. 2, *a*) occur much more frequently within the brain substance. These along with the calcifications which are occasionally encountered in old abscesses and in tuberculomas are roentgenologically not distinguishable from neoplasms. Here again one must seek help from the clinical data for the correct interpretation of the roentgen findings.

The greatest difficulty in the interpretation of intracranial calcification is not the failure to recognize true calcification but the tendency to misinterpret shadows not of this origin. There are numerous possibilities in this respect, only a few of which will be mentioned. Irregularities in the thickness of the cranial bones and the dense ossification frequently seen along the sutures may simulate neoplastic calcification. In excessive pneumatization of the mastoids, the cellular structure may extend for a considerable distance into the temporal and occipital bones and in these locations may be mistaken for calcification. We have seen the shadow of the pinna of the ear interpreted as a tumor. In roentgenograms presenting unusual detail, the patient's hair may give rise to confusing shadows. Such artefacts must be kept constantly in mind.

Increased Intracranial Pressure. The roentgen manifestations of increased intracranial pressure are for the most part readily recognized. These changes consist of convolutional atrophy of the inner table of the bones of the vault, widening of the cranial sutures, thinning of the bones of the vault and occasionally enlargement of the head (Fig. 4). Such findings are to be seen most commonly in children and young adults because the sutures are not yet united and the bones are more susceptible to pressure atrophy. In the interpretation of these various manifestations, one must keep in mind the wide range of variation

in normal individuals. There is considerable variation in the size of the normal head, in the thickness of the bones of the vault and in the appearance of the sutures. Age seems to play little part in the visibility of the cranial sutures.

Most confusion will arise in the interpretation of convolutional atrophy. This appearance results from pressure of the convolutions of the brain against the inner table of the bones of the vault and will be present to some degree in most children and young adults. As such, it may be regarded as a normal physiological appearance. With abnormal increases in intracranial pressure, these so-called digital markings may become excessively prominent. In borderline cases it is often difficult to decide between the physiological and pathological appearance. The roentgenologist does well to pay particular attention to these markings in every head examination so that he may become thoroughly familiar with the many variations to be encountered, since it is only by experience that one can properly evaluate their significance in any given case. A consideration of convolutional atrophy should never be made independent of the other roentgen manifestations of increased intracranial pressure and especially should attention be given to the age of the patient. This finding gains added significance in individuals more than twenty years of age. In younger patients, the changes indicative of increased intracranial pressure, unless marked, are not to be regarded with too much significance unless accompanied by definite clinical findings. It is also to be borne in mind that these manifestations, while frequently found in association with brain tumors, are not in themselves bona fide evidence of such a lesion. They may be found in any condition capable of producing an internal hydrocephalus and must therefore be interpreted simply as manifestations of an increase in intracranial pressure. In this connection, it is well to emphasize the fact that convolutional atrophy requires time for its production. It is a question at least of several months. Convolutional atrophy cannot, therefore, appear as the result of a sudden increase in intracranial pressure, as occurs in head injuries and fractures of the skull.

Localized Bone Erosion. Localized bone erosion, while an important manifestation of brain tumor, is not a common occurrence, aside from the changes seen about the sella turcica. The most outstanding example of this kind is the so-called deformation of the petrous ridge produced by acoustic tumors. The demonstration of

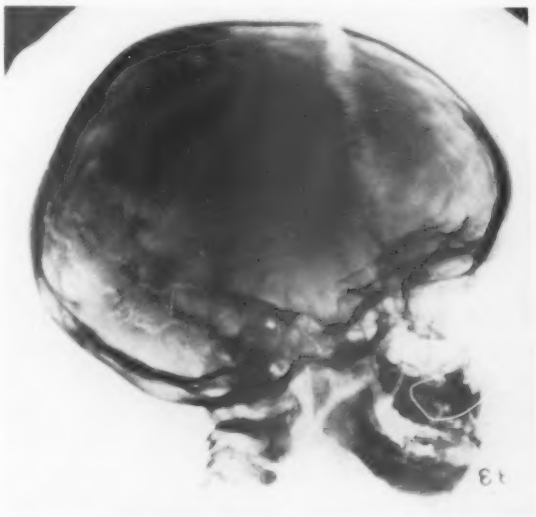

Fig. 4. The roentgen manifestations of increased intracranial pressure, convolutional atrophy, widening of the cranial sutures and thinning of the bones of the vault.

this defect is one of the chief reasons for making an occipital exposure of the head. This gives an excellent view of both petrous ridges and permits a comparison of the abnormal with the normal side. This deformity so adequately described by Pancoast[11] consists of a definite erosion at the site of the porus acusticus or internal auditory meatus. One must familiarize himself with the characteristic depression at the junction of the inner and middle thirds of the petrous ridge which marks the site of the porus acusticus. Evidence of bone erosion at this point (Fig. 5) is the characteristic finding in many cases of

FIG. 5. The characteristic erosion of the left internal auditory meatus due to an acoustic tumor.

acoustic tumor. Most of these cases present a rather characteristic history, beginning with tinnitus followed by increasing deafness in one ear and vertigo over a long period of time. With such a history, one should never neglect taking the occipital view and searching the petrous ridges carefully for evidence of bone erosion.

Occasionally localized bone erosion may occur elsewhere in the skull from pressure of an adjacent tumor. In our experience, this is not a very common occurrence. Mayer[8] mentions this as occurring in the base of the skull from tumors on the under surface of the brain. Such erosions are best demonstrated in the base view (Fig. 6). This is a projection with which every roentgenologist should be familiar. Like the occipital view, this exposure has also received a number of different names, such as the Hirtz position, the corono-mental and vertico-mental projection. While these latter designations indicate the direction of the roentgen beam at the time the exposure is made, we believe that the term base view most accurately describes what is shown in the resultant roentgenogram. This is the view recently advocated by Taylor[13] and Geyman and Clark[4] for the demonstration of petrositis. Those unfamiliar with it would do well to read the articles referred to. In our own practice, we employ the Potter-Bucky diaphragm, which adds materially to the detail which is so essential in this view. Regarding localized bone erosion, this is found much more commonly in conditions other than brain tumor, such as metastatic carcinoma, lues, xanthomatosis and multiple myeloma. They are not likely to be confused with brain tumor, since the lesions in these conditions are most commonly multiple.

Localized Hyperostosis. Localized hyperostosis is a most valuable sign of intracranial tumor. Its clinical significance is due to the fact that it is frequently associated with an underlying meningioma (meningeal fibroblastoma) (Fig. 7, *a*). Such bone changes are usually found in the anterior part of the calvarium, less commonly along the anterior part of the base of the skull (Fig. 8). Occasionally a local-

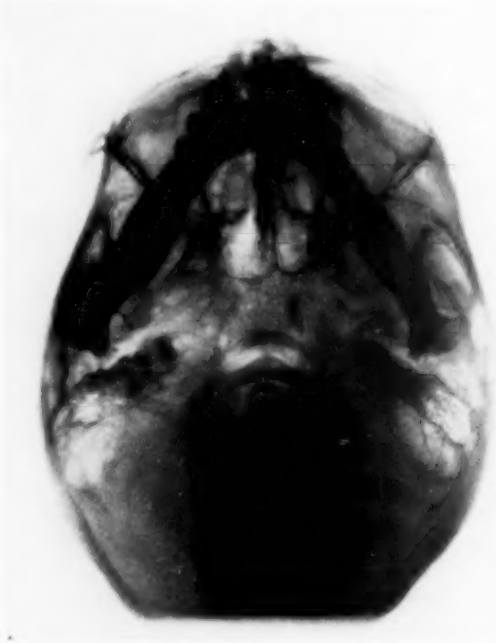

FIG. 6. The base view, of value in the detection of basal tumors which occasionally erode the base of the cranium.

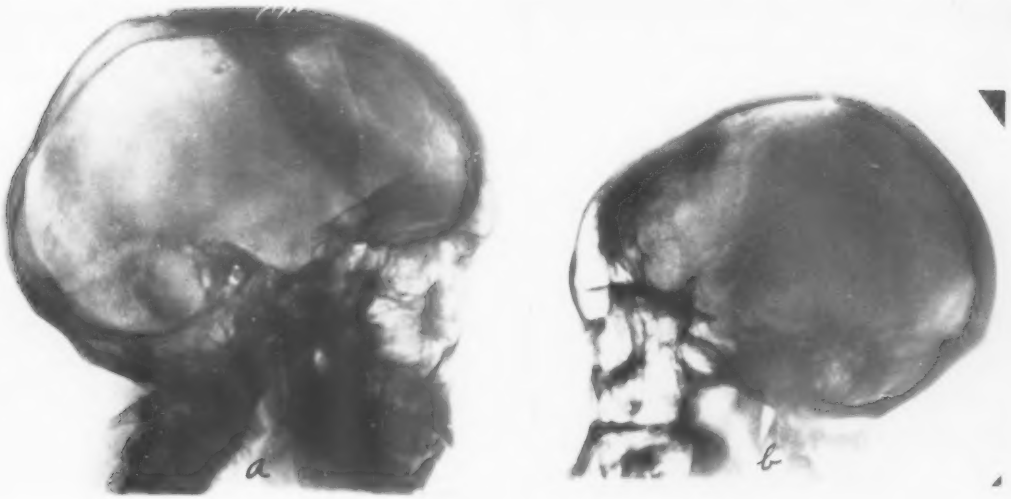

Fig. 7. Two examples of localized hyperostosis: *a*, a large hyperostosis in the frontal region overlying a meningioma; *b*, benign hyperostosis in the frontal region, of no clinical significance.

ized hyperostosis may be the result of an osteoma, especially in the region of the orbito-ethmoidal plate, as described by Cushing.[2] Such osteomata may encroach sufficiently upon the intracranial cavity to give rise to symptoms suggestive of a brain tumor. One pitfall which must be avoided is the recognition of the common condition designated as benign hyperostosis which involves the inner table of the vault in the frontal region. In the average case this is readily recognized. It is almost exclusively limited to females, is found bilaterally, and involves only the inner table (Fig. 7, *b*). According to our present knowledge, benign hyperostosis is of no clinical significance. The hyperostosis of a meningioma is a localized affair involving the entire thickness of the bone and may produce a distinct tumor projecting from the surface of the skull (Fig. 9, *a*). When such external tumors are encountered, a view tangential to the tumor should be made. The exposure should be somewhat decreased so as not to over expose that portion of the mass projecting from the skull. The bone changes associated with meningioma are not always of the hyperostosis variety. Not infrequently there is an actual rarefaction of bone, which is quite irregular in appearance. This is most commonly found in the parietal and occipital regions. The appearance may closely resemble an osteogenic sarcoma (Fig. 9, *b*), which occasionally involves the bones of the calvarium. The differentiation may not be possible roentgenologically.

Displacements of the Pineal Body. Displacement of a calcified pineal body is a manifestation of intracranial pathology

Fig. 8. Localized hyperostosis involving the base of the skull, due to a right sphenoidal ridge meningioma. Note the marked deformation of the sella turcica. Deformation of right optic foramen shown in Figure 10.

that should not be overlooked. With present day refinements of roentgen technique, a calcified pineal body is encountered in approximately 50 per cent of all head examinations. Displacements may occur in the anteroposterior and in the lateral direction. The latter is the more reliable from a diagnostic point of view. Here again the occipital projection is of value, since the pineal body, if visible in the lateral exposure, will usually also be seen in the occipital view. In this connection, it is again necessary to emphasize the importance of proper positioning of the head, since slight rotation will cause the pineal body to be projected to one side of the midline. In the presence of a laterally placed tumor in the cerebral hemisphere a lateral shift of the pineal body is not an uncommon finding, the displacement occurring toward the side opposite the tumor. In lesions such as cortical scars, which may simulate a brain tumor clinically, the pineal body may be found drawn toward the side of the lesion (Fig. 11, *a*).

Vastine and Kinney[17] some years ago reported a method for determining the shift of the pineal body in the anteroposterior direction, while Camp and Gianturco have recently devised an instrument for the rapid utilization of this method. The shift in the anteroposterior direction possesses the same significance as the lateral displacement and the above remarks are equally as applicable.

Less Frequent Manifestations. Localized bulging of the cranial vault at the site of the tumor is an occasional finding. We have seen 3 such cases, reported by Thompson.[14,15] This is most likely to occur with cystic lesions and probably only during childhood, although it may not be apparent or discovered until adult life.

Dilatation of vascular channels in the bones of the vault will occasionally be encountered. Care must be exercised in the interpretation of such findings, in view of the marked variation in size, number and position of the vascular grooves to be found in the normal skull. A unilateral enlargement of the groove for the middle meningeal artery or the spheno-parietal sinus would appear to be the most common examples of this kind. Congenital anomalies or angiomatous lesions involving the intracranial vascular system may produce abnormal appearances in the bones. Such lesions are often suggested by abnormalities in the external blood vessels of the head. Congenital conditions of this kind may at times simulate a neoplasm.

FIG. 9. *a*. Localized erosion and hyperostosis in the frontal region overlying a meningioma with a distinct tumor mass projecting from the skull. *b*. Ostogenic sarcoma of the frontal bone. Note the similarity to the bone changes in *a*.

In recent years, the examinations of the optic foramina and the sphenoidal fissures of the orbit have come into considerable prominence. These examinations in our experience have been rather disappointing. While in a few cases the findings have afforded confirmatory evidence in favor of a brain tumor and have aided in the localization, in an equal number the results have been misleading. The reasons for this are quite obvious, especially as regards the optic foramina, when consideration is taken of the marked variation in the size and shape of these structures and the difficulty encountered in the roentgen technique, in spite of the various devices developed for the simplification of this examination. These facts have recently been emphasized by Keyes.[5] We have come to attach significance to abnormalities in the optic foramina and sphenoidal fissures only when such findings harmonize with other roentgen manifestations (Fig. 10).

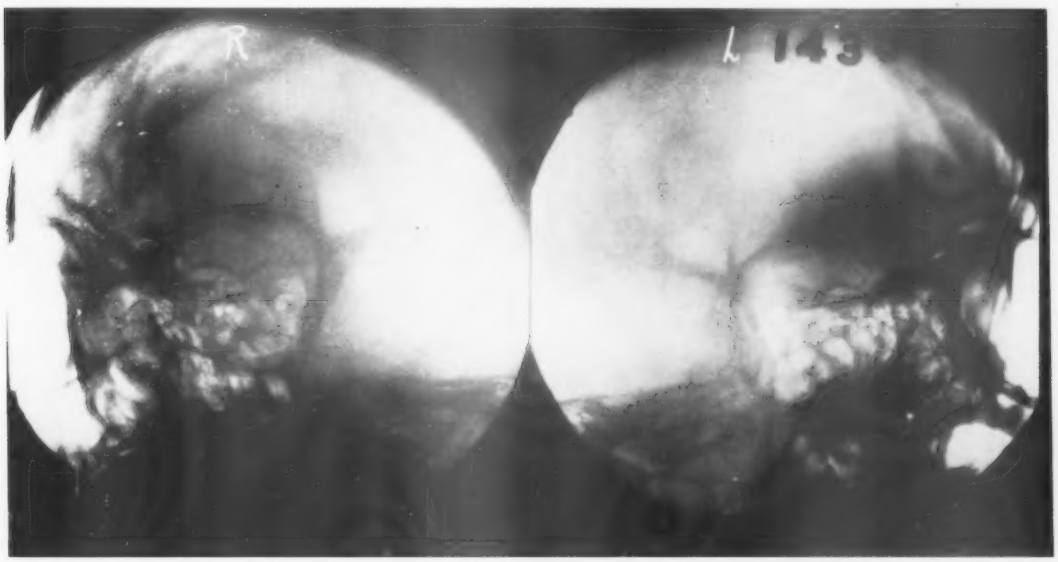

Fig. 10. Deformation of the right optic foramen due to a right sphenoidal ridge meningioma (see Fig. 8).

Conditions which may simulate brain tumor

Chronic Labyrinthitis. The occipital view affords an opportunity to gain some information regarding the condition of the mastoid processes, since these structures are fairly well shown in this view. One should never neglect taking note of the degree of aeration of the mastoids and comparing one side with the other. Not infrequently there will be noted evidence of previous disease. This may be an extremely important finding, indicating the possibility of a chronic labyrinthitis, the symptoms of which may simulate those of a brain tumor. A roentgen and clinical examination of the mastoids may serve to establish the diagnosis of a chronic labyrinthitis as against an intracranial neoplasm.

Cerebral Hemiatrophy. Since the clinical symptoms of cerebral hemiatrophy may resemble those of brain tumor, its differentiation becomes necessary. The condition is probably due to intracranial trauma or infection early in life which results in a failure of normal development of one of the hemispheres. Dyke, Davidoff, and Masson[3] have recently described its roentgen manifestations, most of which may be detected in the occipital examination. There will be noted an asymmetry of the two halves of the calvarium, one side being smaller than the other. The bones of the vault will be somewhat thicker on the smaller side, while the petrous pyramid is larger and the mastoid pneumatization greater than on

the opposite side. A posteroanterior projection will reveal an asymmetry of the paranasal sinuses, best detected in the frontals. The sinuses on the side of the hemiatrophy will be larger than those of the opposite side. Although the cause of the hemiatrophy occurs either at birth or early in life, symptoms do not, as a rule, manifest themselves until many years later, coming on apparently without cause as is symptoms, which can often be relieved by prompt and appropriate treatment.

THE CLINICAL DATA

Finally, one of the most important aids in the detection of intracranial tumors by the roentgenologist is the correlation of the clinical data with the roentgenologic findings. The importance of this cannot be overemphasized. To attempt to interpret

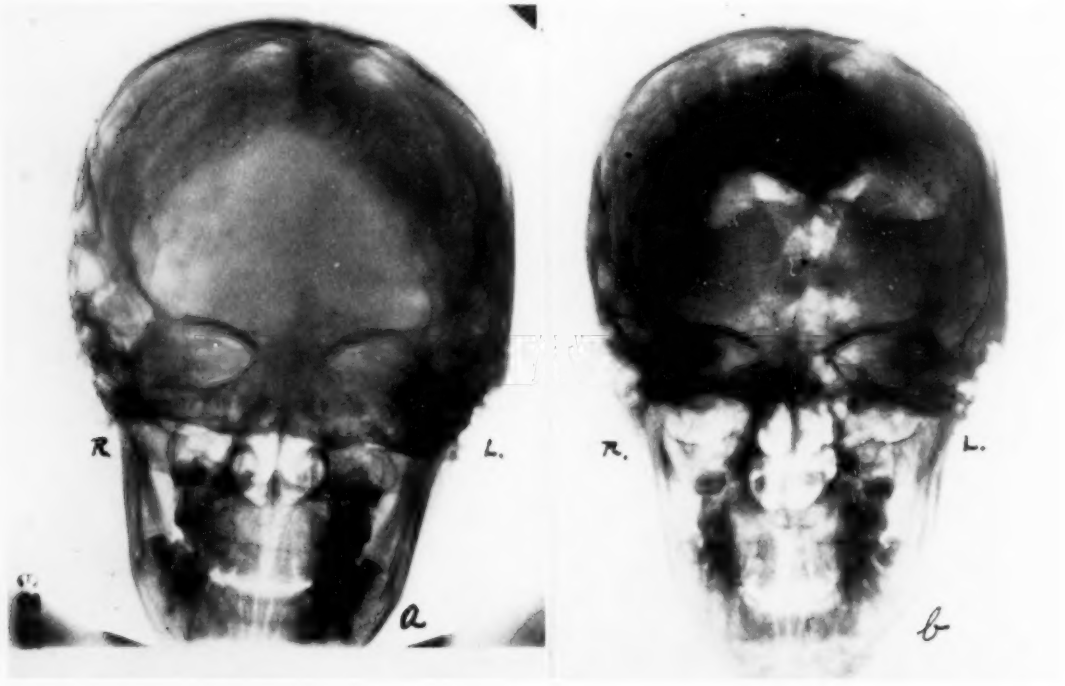

FIG. 11. *a*. Left cerebral hemiatrophy diagnosed on the basis of right-sided Jacksonian attacks, asymmetry of the cranium, the left side being smaller than the right, and a displacement of the pineal body to the left. *b*. Diagnosis substantiated by encephalography showing atrophy of the left cerebral hemisphere with a porencephalic cyst. Confirmed at operation.

the case in brain tumor. Subsequently, encephalography or ventriculography will further substantiate the diagnosis, a porencephalic cyst being found at times in the atrophic hemisphere (Fig. 11).

Sinusitis. Acute or chronic infection in the paranasal sinuses may occasionally give rise to intracranial symptoms. Detection of a pathological process involving the sinuses in roentgenograms made of the head should always be included in the roentgen report. Further clinical and roentgenologic studies may reveal the cause of the intracranial

roentgenograms of the head or any other part of the body without some knowledge of the clinical manifestations, is analogous to an attempt on the part of the clinician to interpret the results of his physical examination without a knowledge of the history of the patient. Neither can be done successfully. The roentgenogram is the roentgenologist's physical examination and the history is as essential to him as it is to the clinician. The roentgenologist cannot hope to establish himself as a consultant unless he familiarize himself with the

clinical data of the patients whose roentgenograms have been entrusted to his interpretation. Success cannot be attained in the roentgenologic detection of intracranial tumors without some knowledge of the neurological manifestations of such lesions. Such knowledge should be in the possession of very competent general roentgenologist. The clinical data required are the chronology of the symptoms, the subjective evidence of increased intracranial pressure, focal symptoms and the positive objective neurological signs. It is only after a careful correlation of the clinical with the roentgen manifestations that one can hope to arrive at the proper interpretation of the roentgenograms in cases of suspected brain tumor.

SUMMARY

1. Since patients with brain tumor are usually first seen by the general practitioner and often first examined by the local roentgenologist, all general roentgenologists must share the responsibility for the early detection of such lesions.

2. To aid the general roentgenologist to a better understanding and to stimulate his interest in the subject of intracranial tumors, the various roentgen manifestations of such lesions are briefly discussed.

3. Attention is directed to some of the pitfalls in diagnosis and a short reference is made to some conditions which may simulate brain tumor.

4. The importance of a careful correlation of the clinical with the roentgenologic manifestations is emphasized.

I desire to acknowledge my indebtedness to Dr. H. K. Pancoast and Dr. E. P. Pendergrass for the use of some of the illustrations appearing in this paper.

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DISCUSSION OF SYMPOSIUM ON BRAIN TUMORS*

DR. JOHN W. PIERSON, Baltimore, Md. Dr. Kornblum comes to us with a challenge which we must accept. He has revealed to us the possibilities of roentgen diagnosis in this difficult field and has shown quite clearly the importance of making an early and correct diagnosis. Too much emphasis cannot be placed upon the remarks which he made regarding the necessity for using exact technique in the examination of the head. The diagnosis many times depends on minor variations from the normal picture which may be readily simulated if the technique employed is not accurate. He has very clearly shown the essential criteria and also the pitfalls to be avoided in the diagnosis of brain tumors.

Dr. Hodges and Johnson's analysis is distinctly encouraging to roentgenologists. They show that, in their series of cases, they were able to obtain, by means of roentgenological examination alone, evidence of brain tumor in approximately 30 per cent of the cases; 50 per cent of the entire group gave neurological signs of brain tumor and an additional 12.5 per cent, which did not give neurological signs, were demonstrated by means of roentgen examination. A comparison of these results with past reports will readily demonstrate the great progress which has been made in this field, which progress has been brought about only by intensive effort and study by those interested. Drs. Johnson and Hodges apply pneumography to the remaining one-third of their cases, which could not be diagnosed by either neurological or roentgenological examination, and obtained very gratifying results, in that they were able to locate approximately 25 per cent of the tumors in this group. It should be noted that their method of handling these cases followed the well-accepted practice of exhausting all other methods of examination before they employed pneumography.

Dr. Nichols' report demonstrates very clearly the value of being able to analyze the results obtained by careful roentgenological examination of the skull either with or without air. He views the evidence seen on the film in the light of the anatomy and physiology of the brain, in conjunction with our knowledge of the pathological and clinical manifestations of brain tumors.

Dr. Dyke's studies are, of course, familiar to all of us. They are immensely important and are outstanding examples of what intense application can produce in this field. The particular subject on which he talks today is very interesting, especially to me, because I have the opportunity to review many ventriculograms. I must confess that I have not recognized the condition which he describes. It is true that we have, in our clinic, seen a number of cases in which the shadow of the choroid appears to be unusually large, but we felt that, inasmuch as that portion of the brain is not often the site of a serious lesion, the apparent enlargement of the choroid was not of much clinical significance. His work emphasizes the fact that we must constantly remember that there is a tremendous variation in the size and appearance of the ventricular system in the normal brain.

DR. M. C. SOSMAN, Boston. Dr. Nichols has selected one group of brain tumors for discussion, the group easiest to diagnose individually by the roentgen ray. He has considered them chiefly by their position rather than by histological type. We are more accustomed to emphasize the type of the tumor as revealed by the roentgen ray, while to the clinician the location of the tumor is the important thing, because the symptoms with a given tumor are due largely to its location and to its size, and not at all to its histological structure. The one exception to this rule is the pituitary adenoma, with which one may have symptoms from the gland itself, either hypo- or hyperactivity as the case may be. The suprasellar tumors, by contrast, do not present symptoms of glandular activity, but they may and frequently do have associated with the symptoms of location a hypoactivity of the pituitary gland, usually inhibition by pressure upon the gland. The chronological development of symptoms is of great importance, i.e., the order in which the various symptoms appear from a tumor in a given region. In the group of pituitary adenomas, the first symptom usually pertains to the gland itself, e.g., amenorrhea, adiposity or impotence. The symptoms of location appear later—blindness, headache, and third ventricle symptoms. On the other hand, the suprasellar tumors reverse the order, the failing vision or headache or peculiar epileptiform seizures, etc.,

* Papers by Drs. Nichols, Dyke, Elsberg and Davidoff, Hodges and Johnson, and Kornblum.

come first, and the hypoactivity of the pituitary gland shows up later. Again there is one exception, this time the craniopharyngeal pouch tumor, otherwise known as the suprasellar cyst, Rathke pouch tumor or craniopharyngioma. In these cases the symptoms of pituitary insufficiency frequently appear early in life so that many of these tumors are seen in children or young adults, who may be dwarfed both physically and sexually but not mentally. Again by contrast, it is rare to find a pituitary adenoma before puberty.

From the above random observations you can all see, as Dr. Hodges and Johnson have stated, how the combination of history, symptoms, physical findings and roentgen findings must go hand in hand, the final diagnosis to be evaluated by the known accuracy or, better, reliability of each contributing factor. But let me give you a word of warning. Do not let yourselves be biased by the history or physical findings. It is better to be absolutely honest with yourself and your confrères by scrutinizing your skull films first without knowing anything about the history and then a second time after you have heard it. In this way you get a truer result from your observations, you are less apt to miss lesions than if your attention has been focused upon a given area, and when your findings and the clinical findings independently coincide, as they often do, it makes them much more valuable than either could be alone.

Dr. Kornblum is to be complimented on his excellent presentation. I am sure that if we all knew the subject as thoroughly as he does a great many patients would be saved untold suffering. Probably his most important statement was that "early diagnosis is just as important in these lesions as it is elsewhere in the body." If you would like to learn more about the subject may I recommend two or three books—the first one is from the clinical, pathological and surgical side by Dr. Cushing, published by C. C. Thomas—the second is one of the Annals of Roentgenology, published by P. B. Hoeber and written by Loyal Davis of Chicago. I understand that both Dr. Pendergrass and Drs. Schwartz and Dyke of New York are writing books on the roentgen diagnosis of brain tumors. When they are ready the diagnosis should be easy for any of us.

The object of the roentgenologist should be three-fold. He should determine first the presence or absence of brain tumors; second, the location of the tumor if present, and third, the type of tumor, if possible. If all three of these can be definitely established he has done his utmost to aid neurological surgery. In a series of our cases reviewed two years ago we found that we could diagnose and locate a tumor in exactly half of the cases and predict its histological type in 25 per cent by the roentgen ray. If ventriculograms were used the tumor could be located in 98 per cent, a very accurate method.

A system of studying films should be employed. You all know that we see only what we look for. This has been brought home to us many times. I should recommend a routine something as follows: *First*, study the bones of the skull for signs of intracranial pressure, the appearance of the sutures, the size and distribution of the blood vessels and any local changes such as destruction or hyperostosis. Pass from that to the *second group*, the frontal and olfactory areas, the temporal fossa, sella, basi-sphenoid, and basi-occipital bones and cerebellar fossa. *Third*, study the sinuses, face, jaw, neck and spine. *Fourth*, search the brain area for abnormal calcification. *Fifth*, locate the pineal body and see if it is displaced. *Sixth*, study the anteroposterior and posteroanterior films and any special views which may have been made. Of course, you have to know what to look for in each of these areas but I shall not attempt to even suggest any points in diagnosis, some of which Dr. Kornblum has covered. Finally, may I give you an example of what may occur if you are brain tumor conscious: Several years ago I spent one hour and fifteen minutes demonstrating a series of roentgenograms of brain tumors in one of the larger towns in northern New York. In the discussion one doctor expressed his pleasure at seeing so many tumors and stated that as far as he knew there had not been a patient with brain tumor in his town in five years so that he did not think he would be able to use the information. A second doctor asked where one would be able to find these cases. I answered the second man by saying that the patients usually went first to the oculist, as failing vision is one of the most common early signs of brain tumor. Many of the others went to the syphilologist on the chance that the queer brain disorder might be luetic. The first man was answered later, for in the next three months we received cases of brain tumor from his town. May I recommend, therefore, that you roentgenograph the skull of any patient with headache and fail-

ing vision or any intracranial symptoms and go over them carefully as Dr. Kornblum has outlined.

Dr. Dyke and his coworkers have added another important fact to the ones already reported from his clinic. This is a most interesting finding he has shown us and his explanation is undoubtedly correct. We have noted this enlarged glomus of the choroid plexus in only one case, as far as I can remember. It is of no clinical importance except to recognize it, particularly when enlarged, and thus possibly prevent an unnecessary operation.

I wish more of us could emulate Dr. Dyke's industry. He spends certain hours every day studying the clinical and pathological aspects of his particular specialty with one of the neurosurgeons, and this and his other contributions to roentgenological literature are evidences of the value of that assiduous application.

DR. SAMUEL S. ALLEN, JR., Pittsburgh, Pa. As Dr. Sosman pointed out, it takes considerable study to diagnose the three features which he mentioned, that is, that a tumor is actually present, the location of the tumor and the characteristics of the tumor. Cooperation from not only the roentgenologist but the ophthalmologist and otologist is highly necessary. Each one plays a very important part and with any one may rest the key to the diagnosis. The observations of the roentgenologist are extremely important. Many of the roentgen studies show very little to aid in the diagnosis and it is in these cases where either encephalography or ventriculography must be resorted to.

In the presence of increased intracranial pressure, I believe encephalography is a rather dangerous procedure, but in some clinics it has been used rather extensively, and with good results.

Our experience with ventriculography has shown it carries but little risk. The method method which I have been using is that of Dr. Max Peet in making just the unilateral opening in the posterior parietal region about an inch back of the external auditory meatus and about 2 inches above. The fluid is withdrawn and the air is then replaced fractionally. It is easy to see, however, that it is a little more difficult to introduce as much air by the method than it is by making a bilateral tap, but with the cranium placed in the various positions, this amount of air which is introduced may be so well utilized that every portion of the ventricular system may be visualized.

To illustrate, when the patient's head is placed with the occiput downward and lateral views of the skull are made, the anterior horns of the lateral ventricles and the anterior portion of the third ventricle may be quite easily visualized, and vice versa, with the forehead down and lateral views being made, the posterior horns and posterior part of the third ventricle and the aqueducts may be clearly brought out.

It is rather difficult to estimate the mortality from ventriculography as many of the patients are operated on within twenty-four to fort-y eight hours after the ventriculograms are made. However, in our experience, we have found the death rate to be almost negligible.

The paper by Dr. Hodges and Dr. Johnson has pretty well demonstrated that it is no longer a question as to whether or not the tumor actually exists in the cranium or as to its location with the thorough roentgen studies plus ventriculography or encephalography, but it is getting now to be more and more an accurate diagnosis of the type of tumor which is present, which will aid the surgeon quite perceptibly in his method of approach.

DR. NICHOLS (closing). I am pleased to see the interest that everyone has shown in this subject. In my opinion, encephalography and ventriculography should be approached in the same spirit as cholecystography or pyelography. These are all phases of roentgenology. There are a great many young men who are being trained in surgery of the brain at the present time and almost all hospitals of importance will be requiring these roentgen studies. If one is to maintain one's position as a radiologist, one must be a consultant in ventriculography and encephalography as well as in other special departments of this field.

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SUPPURATION IN THE PNEUMATIC PETROUS APEX*

By HENRY K. TAYLOR, M.D., F.A.C.P.
NEW YORK CITY

DURING the past few years otologists and roentgenologists have evinced considerable interest in suppuration in the pneumatic petrous apex occurring as a complication of an otitic infection. Heretofore, this lesion was usually diagnosed at post-mortem examination. This complication is now being recognized clinically, and if recognized early enough in many cases, depending upon the type, drainage can be instituted and a fatal cranial complication avoided.

The structure of the petrous portion of the temporal bone may be pneumatic, diploic, or incompletely pneumatized. The structure of the petrous and mastoid portions of any one temporal bone is not necessarily identical. Belinoff and Balan found these two portions identical in 37.5 per cent—in a study of 40 temporal bones, where the petrous pyramids were pneumatized in 35 per cent, diploic in 22.5 per cent and contained mixed cells in 42.5 per cent. These figures indicate that 77.5 per cent of the petrous pyramids show some evidences of pneumatization, while 35 per cent show complete pneumatization. These figures are higher than Myerson's who recently made a study of 200 temporal bones. Hagens' figures, in a study of 50 temporal bones, are similar to those of Belinoff and Balan—34 per cent showed pneumatic spaces in the petrous apex. Profant claims identical structure in petrous and mastoid portions from his study of temporal bones and states, "A specimen with a well developed mastoid had a well developed petrous, and one with a sclerotic mastoid had a sclerotic petrous."

The process of pneumatization of the petrous pyramid is identical to that in the mastoid. It starts either from the inner antral wall, the epitympanic space or from the peritubal region, and goes forward to the petrous tip. Wittmack's theory of pneumatization applies here as well as in the mastoid process. Anything which interferes with the normal process of pneumatization will cause a faulty type of pneumatization, with the result that throughout life there will be either a diploic, a sclerotic or an incompletely pneumatized mastoid process. This also holds true for the petrosa.

The structure of the petrous portion of the temporal bone can be recognized on the roentgenogram. Routine roentgen examinations show a high percentage of cases with pneumatic petrous pyramids. Completely pneumatized petrous pyramids are usually associated with large and extensively pneumatized mastoid processes.

Suppuration in the petrous apex may occur in any type structure of bone. If the petrous pyramid is composed of diploic bone, an osteomyelitis results. When pneumatization is present, changes result which are analogous to a suppurative lesion in a pneumatized mastoid process—a coalescent petrositis or an empyema of the petrous apex.

This presentation is based on a study of 30 cases* which presented suppurative lesions in pneumatic petrous pyramids. Roentgenologically, *the pneumatic petrous pyramid shows a change from the normal with any otitic infection.* For this reason I wish to present the roentgen appearance of the pneumatic petrous pyramid, with various otitides.

1. *Acute Purulent Otitis Media.* The petrous pyramid shows a generalized diminution in aeration in every case of of acute purulent otitis media. The trabeculae appear thickened and are intact. There are no destructive changes. There is

* Detailed case reports of most of the cases have already been published. See bibliography, references 1, 4 and 7.

* From the Department of Roentgenology, Beth Israel Hospital, Dr. I. Seth Hirsch, Director. Read at the Thirty-fifth Annual Meeting, American Roentgen Ray Society, Pittsburgh, Pa., Sept. 25–28, 1934.

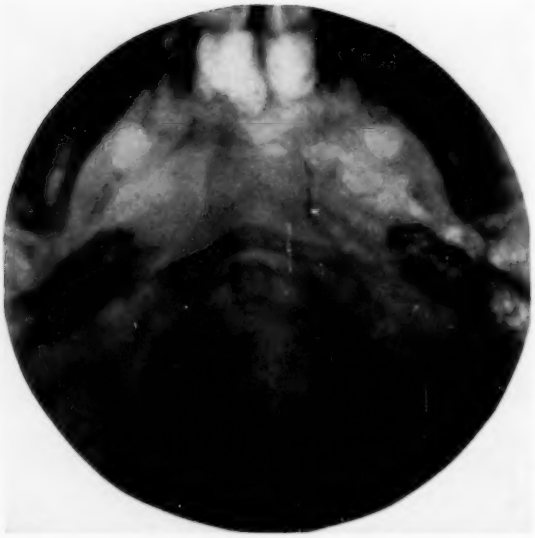

FIG. 1. S. S. Suppuration (acute) in left petrous apex with inadequate drainage. Left petrous apex: decalcified, no trabeculae visible.

no atrophy. The apical contour is distinctly visualized, and is intact. This accompaniment to an acute otitis media is not due to a suppurative lesion in the petrous pyramid. The diminution in aeration of the petrous pyramid is due to a congestion and edema of the mucous membrane lining the air spaces. The mastoid process is the site of a similar change in aeration, at the same time. This change in aeration of the pyramid is so pronounced, when compared to the normal side, that the diseased ear can be detected from the appearance of the petrous pyramid.

2. *Acute Coalescent Mastoiditis.* The petrous pyramid also shows a diminution in aeration when there is an extension of the infection from the middle ear into the mastoid process resulting in a destructive or coalescent mastoiditis. The findings are essentially the same as those found with an acute otitis media; they are more pronounced, because the congestion and edema in the petrous pyramid are more marked. There is a marked decrease in aeration, a generalized increase in density. The trabeculae, while thickened, show *no evidences of softening or destruction.* There is no atrophy and the apical contour of the pyramid is visualized and intact. These changes do not indicate a suppurative lesion in the petrous apex. Even after mastoidectomy for a coalescent mastoiditis, the petrous pyramid will show a similar change, until there is complete restitution to normal.

3. *Chronic Suppurative Otitis Media.* Here the petrous pyramid shows a generalized diminution in aeration where a pneumatic petrosa is found. However, a pneumatized pyramid is the exceptional rather than the usual finding in the presence of a chronic purulent otitis. There is no atrophy and there are no destructive changes. There is no infection in the petrous apex. The diminution in aeration is due to the attendant congestion and edema of the mucous membrane when present. A cholesteatoma does not enter into the discussion for it does not occur in a pneumatic bone.

4. *Suppuration in the Petrous Apex, with Inadequate Drainage.* The petrous pyramid shows a diminution in aeration with an increase in density in the basal or labyrinthine portion. The apical portion of the petrous pyramid shows a marked decrease in density. There is marked decalcifica-

FIG. 2. J. K. Suppuration (acute) in left petrous apex with inadequate drainage. Left petrous apex: decalcified, no trabeculae visible.

tion of the entire petrous apex. The trabeculae may show evidences of softening or destruction, these changes becoming more pronounced as the lesion progresses. The halisteresis may be so intense that the apical contour is either faintly visualized or not visualized at all. The fact that the contour of the petrous apex is not visualized does not indicate apical perforation. As the lesion progresses, perforation and destruction of the apex may ensue. These changes are quite striking and the demarcation between the petrous apex and labyrinthine portions are definite and pronounced, and are due to a suppurative lesion in the petrous apex—an empyema. If drainage from the suppurative lesion in the petrous apex is inadequate, this roentgen picture accompanies a given symptom-complex, and requires surgery to avoid an intracranial complication.

5. *Suppuration in the Petrous Apex, with Adequate Drainage.* The changes in the appearance of the pyramid are essentially the same as those described when drainage is inadequate. The demarcation between the apex and labyrinthine areas may not be so pronounced. The basal portion of the pyramid shows a decrease in aeration, an increase in density. The trabeculae may be partially or completely softened or destroyed. The apical portion is decalcified. The apical contour may or may not be visualized. The spontaneous institution of adequate drainage, development of a fistulous tract wide enough to permit drainage, through the middle ear or wound, modifies the typical clinical picture, which I shall describe later, and may prevent an intracranial complication. This lesion may persist and be the cause for a persistent otorrhea, as next described.

Fig. 3. A. M. Suppuration (acute) in left petrous apex with inadequate drainage. Left petrous apex: decalcified, no trabeculae visible.

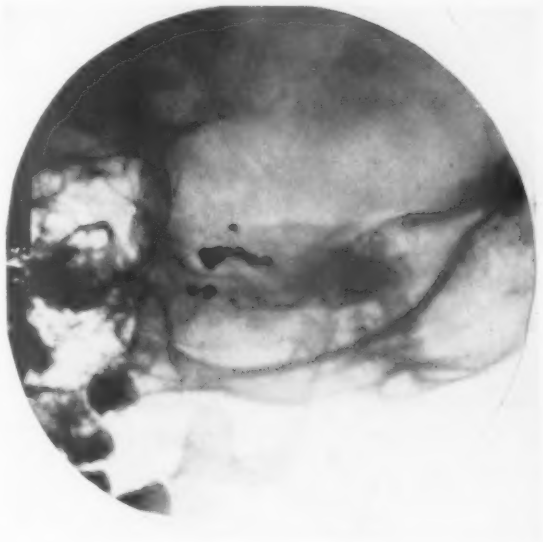

Fig. 4. A. M. Same as Figure 3. Lipiodol instilled at time of drainage operation. Perforation indicated by escape of contrast substance from the confines of the petrous apex.

6. *Suppuration in the Petrous Apex—Persistent Otorrhea.* A number of cases after mastoid surgery have a persistent otorrhea. Some of these cases have the source of the infection in the petrous apex. These pyramids show a generalized diminution in aeration with a generalized increase in density. There is a partial sclerosis of the pyramid—productive osteitis secondary to the infection in the petrous pyramid. The remaining trabeculae become markedly thickened. These reparative changes are superimposed upon the original destructive lesion. This lesion may follow an otitic infection without mastoid in-

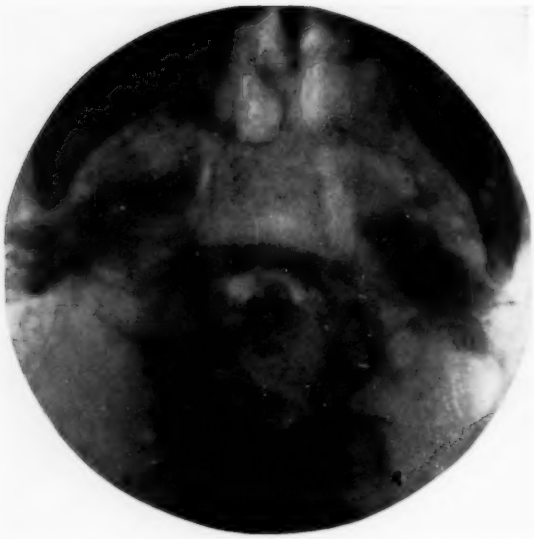

Fig. 5. F. A. D. Jr. Suppuration (acute) in right petrous apex with inadequate drainage. Right petrous apex: decalcified, no trabeculae visible.

volvement as well as an empyema in the petrous apex with adequate drainage, where there has been a destruction of the trabeculae. There is no restitution of trabeculae, but there develops a productive bone change secondary to the infection in the petrous pyramid.

7. *Healed Suppurative Lesion in the Petrous Apex.* The petrous pyramid shows a generalized increase in density. Restitution occurs by a productive bone change. The pneumatic structure is replaced by dense compact bone. There is no reformation of cells.

The roentgen findings in the above illustrated types of otitic infections may be divided into two main groups. First, those types which show halisteresis of the petrous apex of which there are two, and second, those types which do not show halisteresis of the petrous apex of which there are five. A suppurative lesion in the petrous apex is present in the two types showing halisteresis, and in only one type showing an increase in density—a productive bone change.

The suppurative lesions in the petrous apex, depending upon the *history*, *clinical* and *roentgen* findings may be designated as acute, subacute and chronic.

1. *Suppuration in the Petrous Apex—Acute.* The history is usually that of a simple mastoidectomy on an extensively pneumatized bone followed by a normal convalescence. After a period of well being—which may be from a few days to several weeks and sometimes months—there is a sudden reappearance of an aural discharge, a low grade sepsis and pain along the ophthalmic branch of the fifth nerve. The pain is usually located in or behind the eye. This symptom-complex was described by Kopetzky and Almour, and is due to the inadequate drainage of the abscess or empyema in the petrous apex. At operation several cases showed fistulous tracts. These tracts did not permit adequate drainage, otherwise the eye pain would not have appeared. A roentgenogram shows findings as previously described under suppuration of the petrous apex with inadequate drainage. This type of case requires immediate surgical intervention for drainage of the petrous apex. This is the only type which is of immediate concern to the otologist, for if left alone an intracranial complication with a fatal outcome is certain to follow.*

All the cases in this group, 25, with 2

* Fowler recently reported autopsy findings in 6 cases of meningitis of otitic origin following petrous pyramid suppuration. He also reported the recovery of a case with a suppurative lesion in the petrous apex following surgery (through the courtesy of Dr. John Kernan, from the service of Prof. Cornelius G. Coakley).

Fig. 6. F. A. D. Jr. Same as Figure 5. Lipiodol instilled at time of drainage operation. Perforation present. Wide dissemination of contrast substance into all cranial fossae.

exceptions, appeared as a complication following mastoid surgery. Of the 2 cases, one was recognized, and operated upon for petrous drainage at the time of the mastoidectomy; the second was not recognized, and required a subsequent operation for petrous drainage. Anatomically, it is possible for an infection to extend into the petrous apex and develop a suppurative lesion as a complication to an acute purulent otitis media, or a coalescent mastoiditis before surgery has been instituted, or before the mastoiditis has fully developed.

2. *Suppuration in the Petrous Apex—Subacute.* The persistence of an aural discharge following a recent simple mastoidectomy on a pneumatized mastoid is the history usually obtained. There may be no clinical symptoms other than an otorrhea. A roentgenographic examination reveals the changes described above under suppuration of the petrous apex with adequate drainage. Here a fistulous tract is present which adequately discharges the contents from the petrous apex externally. When drainage is adequate, surgery, as a life-saving measure, is not necessary but should be undertaken if a chronic otorrhea is to be avoided. The typical symptom-complex described by Kopetzky and Almour is absent.

Fig. 7. J. K. Suppuration (subacute) in right petrous apex with adequate drainage. Decalcification and non-visualization of the petrous apex—perforation suspected. Symptom-free except for otorrhea since mastoidectomy, three months ago. Lipiodol, instilled at time of drainage operation, is confined to petrous apex. There is no perforation of the petrosa even though the apex is not visualized.

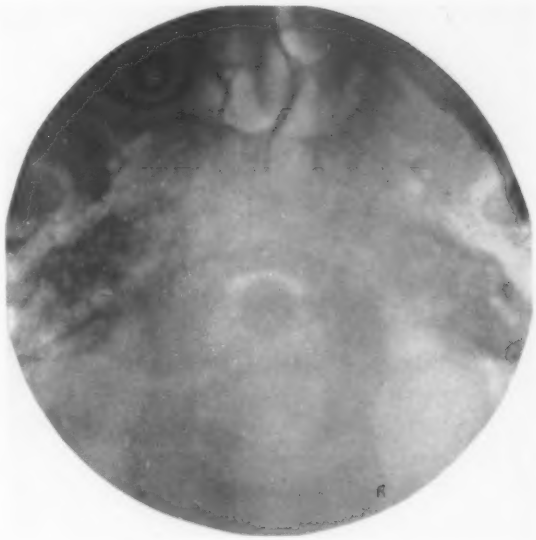

Fig. 8. M. C. Suppuration (chronic) in right petrous pyramid. The right pyramid shows an increase in density. Persistent otorrhea, right side, for two years since mastoidectomy.

3. *Suppuration in the Petrous Apex—Chronic.* A history of mastoid surgery may or may not be present. The usual history is that of mastoid surgery, with a persistent otorrhea, and often there is a history of one or more revisions. The roentgen findings are those described under suppuration in petrous apex with persistent otorrhea.

From the foregoing it is quite apparent that a history of the case is essential to correctly interpret the roentgen findings in the petrous portions of the temporal bone irrespective of the nature of the otitic infection—whether it be acute, subacute or chronic. The newness of this work has naturally put both the otologist and roentgenologist on the alert in the detection of these lesions. The remarkable success of surgery in the cure of this hitherto fatal complication has encouraged keener diagnosis and early intervention. Nevertheless, many cases are seen which may suggest

petrosal suppuration, but, when subjected to careful analysis, prove not to be. The studied evaluation of clinical symptoms by the otologist and the accurate interpretation of roentgen findings by the roentgenologist will avoid errors in diagnosis. It is therefore of the utmost importance to remember that only those changes in the roentgenogram are to be considered as diagnostic which point to a destructive lesion. Changes in density, or diminished aeration are not indicative of a suppurative process in the petrosa. To paraphrase an old saying of Jackson's—"Everything that wheezes is not asthma"—in the same way *every change in the appearance of the petrous apex is not a suppurative lesion in the petrous apex.*

All cases of suppuration in the petrous apex, diagnosed and operated upon, are verified at operation by the instillation of lipiodol, either through the fistulous tract if present, or the drill hole made by the Almour operation. Only by the use of contrast substance can a perforation in the petrous apex be definitely determined. I have seen cases where the halisteresis was intense and perforation suspected because the apical contour was not visualized. Roentgen examination after the instillation of lipiodol in these cases showed no escape of the contrast substance from the confines of the petrous apex. Other cases where the contour of the petrous apex was completely visualized and appeared intact showed escape of the lipiodol into the cranial cavity. The contrast substance may escape into the anterior, middle and posterior fossae, and also over to the opposite side. In only one instance was there a collection of contrast substance in the posterior fossa below the tentorium. Most cases show the contrast substance in between the layers of the tentorium. Another group of cases show a localized collection of the contrast substance at the site of the perforation in the petrous apex. The site of perforation in these cases is sometimes suspected roentgenologically, before the instillation of the contrast substance.

The technique I use has already been published and it will therefore not be repeated here. However, I wish again to call attention to the importance of a routine roentgenogram of the base of the skull at the time of roentgenography of the mastoid processes. Law, at the last annual meeting, in discussing the examination of the mastoid processes, also urged this procedure. This film is of considerable value. Should a subsequent lesion develop in the petrous pyramid, you have a film for comparison to detect the changes.

When a lesion is suspected in the petrous apex, anteroposterior oblique views of the pyramids should be made in addition to a film of the base of the skull. The film of the base of the skull I consider most effective in diagnosing suppurative lesions in the petrous bone. The other view may help to confirm or corroborate the findings of a suppurative lesion, but, contrary to recent publications, in my experience it alone is not diagnostic. It is of real value in the detection of an epidural abscess in the anterior portion of the pyramid which cannot be recognized on a film of the base of the skull.

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DISCUSSION

Dr. K. M. Day, Pittsburgh, Pa. The essayist has given some valuable contributions in this and former papers which are helping to broaden our knowledge of changes which take place in the petrous bone during otitic infections. My discussion must necessarily be from the clinician's standpoint.

Pneumatization of the petrous bone originates from middle ear, attic and antrum. Cells develop inwards and around the labyrinth from three sources: (1) peritubal cells anterior to the labyrinth; (2) zygomatic and epitympanic cells over the roof of the labyrinth; (3) cells developing inwards from the antrum posterior to the labyrinth. The peritubal cells are the only ones which cannot be reached by means of the simple mastoid operation. Consequently, when pneumatization of the petrous apex takes place by this route and suppuration occurs in the petrous apex, the operative approach must be through this area by means of the Almour technique or else through the middle cranial fossa. Where there is an extensive pneumatization over or behind the labyrinth, the petrous apex can usually be reached by means of the simple mastoid route, and this is true in the majority of cases.

The usual history of cases with suppuration in the petrous apex, as Dr. Taylor pointed out, is that of a simple mastoidectomy with a varying period of convalescence and then a flare up of signs and symptoms of infection in the petrous apex.

In other words, the mastoidectomy is often incomplete. With roentgenograms taken before operation, showing the extent of pneumatization of the mastoid and petrous bones, the operator may be guided in his work and by a more complete exenteration of the mastoid process and adjacent cells will prevent many of the serious and often fatal cases of petrositis.

It must be emphasized that the decision to operate on the petrous apex must not rest with the roentgen examination. At the meeting of the American Medical Association in June, Coates reported a series of 9 cases in which the roentgenograms showed evidence of bony destruction in the petrous apex and which also showed clinical signs of petrous infection and yet recovered without radical surgery being instituted. Over enthusiasm in attacking a newly described infective process is resulting in the sacrifice of the middle ear structures and consequently the useful hearing of many patients unnecessarily, to say nothing of the actual danger to life in carrying out the difficult surgical procedures necessary for draining the petrous apex. On the other hand, the prompt surgical drainage of this area when an actual suppurative and destructive lesion is present is essential to prevent a fatal septic meningitis. For this reason the closest cooperation between the roentgenologist and the otologist is necessary. Good roentgenograms, properly interpreted, are an invaluable aid not only in reaching the proper diagnosis but also in determining the best route for operative approach. The information which the otologist has a right to expect covers three points: (1) Is there a destructive lesion in the petrous apex? (2) If so, which part of the apex is involved in the lesion? (3) What is the extent of the pneumatization? The roentgenologist must realize the extent of his responsibility. Poor roentgenograms, incorrectly interpreted, may be the deciding factor in causing the otologist to operate unnecessarily.

BRONCHIOLECTATIC EMPHYSEMA OF ADULTS

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EXPERIENCE teaches that this condition is a rare pulmonary anomaly the clinicopathological concept of which is, with few exceptions, similar to bronchiectatic disease. Its causative factors are the same and the two conditions are always present in the same chest.

Interest in this anomalous pulmonary condition, bronchiolectatic emphysema of adults, or more properly termed *polycystic disease of the lung with bronchial communication*, originates chiefly from its genesis. During prenatal life, end buds of the fetal bronchi normally put out epithelial invaginations into the prolific interstitial tissue. These have as their ultimate purpose normal respiratory alveoli. If, however, these invaginations do not form, blind, terminal bronchioles remain and pass into adult life as infantile structures. This arrest of bronchoparenchymal development does not ordinarily occur with all the bronchioles of a lobe or a lung, but is multiple, scattered and bilateral so that each malformed, terminal bronchiole is imbedded in resilient, air-filled respiratory alveoli. If a stem bronchus fails to develop, a whole lobe would, in accordance with the development of pulmonary cysts, be occupied by a single large multilocular cyst.[1] When postnatal life begins, inflation of the lungs increases chest volume as does subsequent growth. This increased volume must be filled, and the thin, atrophic walls of the anomalous preterminal and terminal bronchioles distend to form emphysematous bullae. By alveolar proliferation and by this process of distention of the fetal end buds, the terminal bronchioles and the preterminal bronchioles, after the fourteenth year of life when bronchial branching and alveolar proliferation ceases, the lungs grow in size, keeping pace with the increasing thoracic volume. Pollock and Marvin[2] stressed the importance of bronchial constriction as a causative factor. This type of lung in adult life can well be called the "honeycomb lung" or polycystic disease in which there is bronchial communication with and inflation of the cysts at all times.

If the preterminal bronchioles are occluded during prenatal growth, the end buds and terminal bronchioles remain as closed cysts to form the cystic lung of a closed-cyst type.

When adult life has been attained, all influences responsible for infantile bronchi passing from dry bronchiectasis into bronchiectatic disease have been operating to produce further distention of these emphysematous bullae of the patent type of polycystic lung and the accompanying widened bronchi. These influences are thoracic suction on inspiration, expiratory push, cough with its markedly elevated expiratory push, infection, and parenchymal fibrosis. Both bullae and bronchi are now chronically infected, their walls alternate between granulation and epithelization; interstitial tissue and adjacent aveoli are being slowly incorporated into a chronic inflammatory process with fibrosis and atelectasis ensuing. Middle age, if attained, finds these individuals in a deplorable condition. General failure, which necessarily must develop, comes from physiopathological changes and not from bronchopulmonary infection alone because chronic infection has immunized them to an extent that new, virulent organisms are well tolerated. The remaining respiratory alveoli not incorporated in the inflammatory process about the cysts and bronchi have become emphysematous so that air hunger is present; chronic nephritis, myo-

[1] Herms, J., and Mumme, C. Ueber kongenitale Bronchiektasie und Cystenlunge. *Beitr. z. Klin. d. Tuberk.*, 1931, 77, 701–716.

[2] Pollock, W. C., and Marvin, H. P. Congenital cystic disease of the lung. *Am. Rev. Tuberc.*, 1933, 27, 59–66.

carditis, emaciation and debility complete a picture of general physical disintegration.

CASE REPORTS

Case I. J. F., admitted February 15, 1933; Czechoslovakian, male, aged thirty-nine. Coal miner until five years before admission at which time he became a silk weaver and pursued that occupation until admission. Married and father of 4 healthy children. First consulted physician for present illness in June, 1932. States that he has had a dry cough since childhood; always susceptible to colds accompanied by fever, cough and expectoration. Two months previous to admission became incapacitated for work; dyspnea, weakness, interscapular and substernal pain all becoming more severe. Blood-tinged sputum was observed at this time.

Physical Examination. Apparently forty-five years old, debilitated but not acutely ill. Moderate dyspnea and mild cyanosis present; well oriented. Pigeon breasted, scaphoid abdomen, weight 99 pounds. Extremities negative except for emaciation and clubbing of fingers. Heart negative, blood pressure 110/80; pulse 90; temperature 98° F. Chest examination revealed impaired percussion note over left base anteriorly and right base posteriorly. Hyperresonance was present over remaining basal areas. Auscultation revealed crepitant, subcrepitant, and atypical sibilant and sonorous râles throughout the lower two-thirds of both lung fields front and back. Breath sounds were suppressed throughout both lung fields.

Laboratory Examination. Leucocyte count 14,000 total, with mild neutrophilia present. Erythrocytes 3,889,000, hemoglobin 73 per cent. Urine negative. Kahn test negative. Blood sedimentation test 17 mm. first hour. Sputum positive for an occasional spirochete, as was smear from gums; negative for fungi, yeast and tubercle bacilli.

Roentgen Examination. See Figure 1.

Progress. Postural drainage, bed rest and instillations of lipiodol improved all symptoms promptly. Residual lipiodol, contrary to Pollock and Marvin's observation, was not observed for long periods.

Case II. A. C., admitted July 16, 1932; Italian, female, aged thirty-seven, housewife. Admitted complaining of cough, expectoration, deep pain in the right hypochondrium, dyspnea, loss of weight, weakness, anorexia and lassitude. Onset of cough four years previously, following child birth, at which time she had "pneumonia" accompanied by elevation of temperature. After patient's general condition improved she recalled having had frequent colds with continuous cough for many years. Mother of 8 children; habits good.

Physical Examination. Apparently about forty years old, dyspneic, disoriented, restless; mild cyanosis of nails and lips; mucous membranes anemic; mild edema of feet; general appearance poor showing obvious weakness. Weight 83 pounds; pulse 100; temperature 99.2° F. No clubbing of fingers. Moderate ten-

Fig. 1. Case I. Bronchogram of right bronchial tree, showing bronchial dilatation and multiple pulmonary cysts, their patency being proved by the ease with which the opaque medium entered them. Bronchograms are adequate to diagnose these cases, and this patient requested reinstillation of lipoidol, for the beneficial effect on his disease. Case II, however, experienced some increase of dyspnea, had moderate pyrexia and edema of eyelids. These symptoms were all temporary. Edema of the larynx did not occur. Recovery from these symptoms was prompt. Observe the emphysema present in Figure 1. A small amount of opaque medium has outlined three cysts in the left lung. Subsequent instillations of lipiodol revealed cylindrical bronchiectasis of both bases accompanied by cysts.

derness over right hypochondrium. Gallbladder not palpable; liver not enlarged. Chest examination revealed percussion note impaired throughout both lungs anterior and posterior, and crepitant, subcrepitant, atypical sibilant and sonorous râles lower two-thirds of both lungs, anterior and posterior.

Laboratory Examination. Leucocyte count 8,400. Differential count normal. Erythrocytes 3,400,000; hemoglobin 70 per cent. Urine: albumin+, epithelial casts. Sputum: negative for tubercle bacilli. Blood Kahn test negative.

Roentgen Examination. Numerous, well-differentiated, annular shadows 1 to 2 cm. in diameter scattered over entire right lung field and lower two-thirds of left lung field. Well-contrasted films were required to demonstrate these shadows. Lipiodol injection of bronchial trees to both lower lobes demonstrated these annular shadows to be patent pulmonary cysts.

Progress. Postural drainage and bed rest improved all symptoms.

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THE VEILED AIR BUBBLE IN HYDROPNEUMOTHORAX*

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THE roentgen diagnosis of hydropneumothorax is generally very simple if the examination is made with the patient in the erect position; there is the typical combination of the dense shadow of the opaque fluid capped by the transparent air bubble. In cases of long standing, with the lung largely reëxpanded, the air pocket, however small, generally appears in the axillary region of the chest, above the fluid in the complemental space. However, there are certain cases in which the lung does not expand uniformly and equally in all directions, from the hilus outward. In patients confined to bed for long periods after a spontaneous or traumatic pneumothorax, the upper or anterior lobe is likely to expand first and to adhere to the chest wall, while the lower lobe expands more slowly; the fluid, in the recumbent position keeps the posterior and lateral portions of the lung from contact with the chest wall, thus preventing adhesions and delaying reëxpansion. A roentgenographic examination, in the erect position, in such case, will fail to show the air bubble distinctly, as the shadow of the partly expanded lung and that of the air pocket back of it combine to produce an illusion of normally inflated lung tissue. Then, too, the shadow of the fluid at the bottom of the pleural cavity may not have the typically horizontal upper border. The fluid often contains a good deal of blood which has escaped into the pleural cavity during the original lung injury, or perhaps is otherwise rich in fibrin. The partly expanded lung has considerable respiratory activity and it seems to churn the coagulated top layer of the exudate into solid masses of various shapes. The cylindrical, spindle shaped, and globular masses of fibrin have been described in such cases. For these reasons, it can be understood why the line of air and fluid junction in these cases should vary from the diagnostic horizontal fluid level. In the case reported by Yater and Rodis[1] this border was convex upward; in our Case 1, the upper border of the exudate was concave upward.

In these cases the diagnosis of pneumothorax can be made only by observing the readiness with which the fluid shifts during changes of posture and by the fluid wave seen roentgenoscopically when the patient is shaken. If the heart action is vigorous, as after exercise or excitement, the fluid wave may be seen with each heartbeat.

We wish to emphasize in this connection that pleural effusions, unaccompanied by air, do not change position markedly with changes in posture. Certain changes in roentgen appearances occur, but they are slight in degree and extent, and depend largely on the changes in the shape of the chest wall, and on the shifting of the abdominal viscera which result from changes in posture. All pleural effusions are preceded by dry pleurisies which bring about adhesions or at least deposits of fibrin which enhance the friction between the pleural membranes and thus counteract in a large measure the hydrostatic pressure. In hydropneumothorax, on the other hand, the factor of friction is negligible. It is to be remembered that here we are dealing with air and liquid, substances differing in specific gravity and roentgen-ray density, substances which easily rearrange themselves in response to gravity and during changes of posture produce striking differ-

[1] Yater, W. N., and Rodis, I. Unusual case of pleural effusion simulating elevation of the diaphragm. Am. J. Roentgenol. & Rad. Therapy, 1933, *29*, 813–814

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FIG. 1A. Case 1. Shadow of fluid at left base. Heart displaced to right, The upper border of the fluid is concave upward. Apparently normal lung above the fluid.

FIG. 1B. Case 1. Patient lying on his back with hips elevated. The fluid has distributed itself over entire left side of chest.

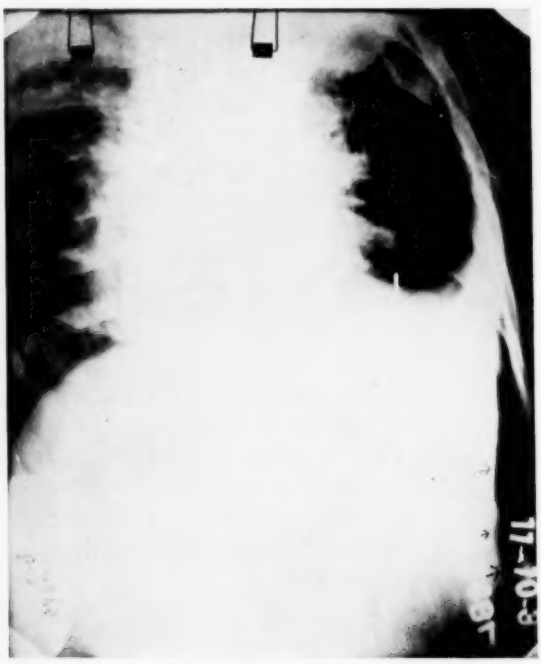

FIG. 1C. Case 1. Taken at same time as Figures 1A and 1B. Patient lying on right side, sand bag under the right hip. The fluid has horizontal upper border, distinct air pocket above fluid. Note that the fluid level is not a perfectly straight line.

ences in roentgenograms made in the different postures.

Reviewing the case of Yater and Rodis in the light of the above remarks, we find the following significant features: a tuberculous individual had blood-tinged free fluid in the left pleural cavity. With changes in posture the fluid changed position in a "startling" manner, it also showed a wave with each heart beat. At autopsy much fibrin was found, and there were fresh adhesions. The left lung was partly collapsed. This is as good a picture of partial pneumothorax as ever presents itself at autopsy. The direct demonstration of intrapleural air cannot be expected unless the chest is opened under water.

In order to visualize the pneumothorax roentgenoscopically in cases in which adherent lung obscures the air pocket in the erect posture, it is necessary to place the patient in such a position that the air bubble will come to rest above the fluid in a region devoid of adherent lung. The most favorable position is usually that with the patient resting on the healthy side, a sand bag under the hip; thus the typical

picture of hydropneumothorax appears in the lower axillary region of the affected side.

In conclusion, we wish to present 2 cases in which the findings were similar to those described by Yater and Rodis but the roentgen examination in lateral recumbency showed conclusively that we were dealing with a hydropneumothorax in each case.

Case 1. White male, aged thirty-eight. On October 17, 1931, the man had a sudden onset of pain in the left chest and shortness of breath. He was delirious that night and the doctor said the patient had pneumonia. The temperature was normal the next morning, but the patient was kept in bed twelve days. On November 10 the left side of the chest had limited motion, absence of tactile fremitus, of resonance, and of breath sounds in the axilla and below the 7th dorsal vertebra on the left side. Roentgenoscopic examination, the patient erect, showed the shadow of a pleural effusion above the left diaphragm, its upper border appeared horizontal but no air could be seen above the fluid. Tapping upon the chest with a finger produced waves in the fluid. Upon bending the patient over to the right the fluid was seen to shift and an air bubble appeared in the left axilla (see Fig. 1).

Aspiration of the chest through the 8th and 9th interspaces below the left scapula yielded a bloody fluid with a hemoglobin content of 40 per cent.

On December 5 the hemoglobin content in the pleural fluid was 15 per cent, on December 28 the hemoglobin was less than 10 per cent. The fluid and air absorbed completely in the course of three months.

During the summer of 1932 the patient was readmitted to the hospital with findings of pulmonary tuberculosis.

Case 11. White male, aged forty-five. On November 15, 1932, the man was run over by a team of horses, several ribs were broken. He spat blood, and "his body swelled up with air under the skin" (subcutaneous emphysema). He was in bed six weeks. On December 1, 1932, the left side of the chest was deformed and bulged at the base posteriorly. There was absent fremitus, and flatness on percussion below 5th rib and 7th dorsal spine in the erect posture. In the recumbent position there was hyperresonance throughout the left side. In the erect position the breath sounds were absent on the left side below the nipple and 8th dorsal vertebra, in the supine position the sounds were normal anteriorly as far out as the mid-axillary line. The heart was displaced to the right.

Roentgenoscopic examination showed a dense shadow at the base of the left lung with a horizontal upper border, no air bubble above, but rather normal lung. The upper border of the shadow showed a fluid wave with each heart beat. Shaking of the patient also showed this

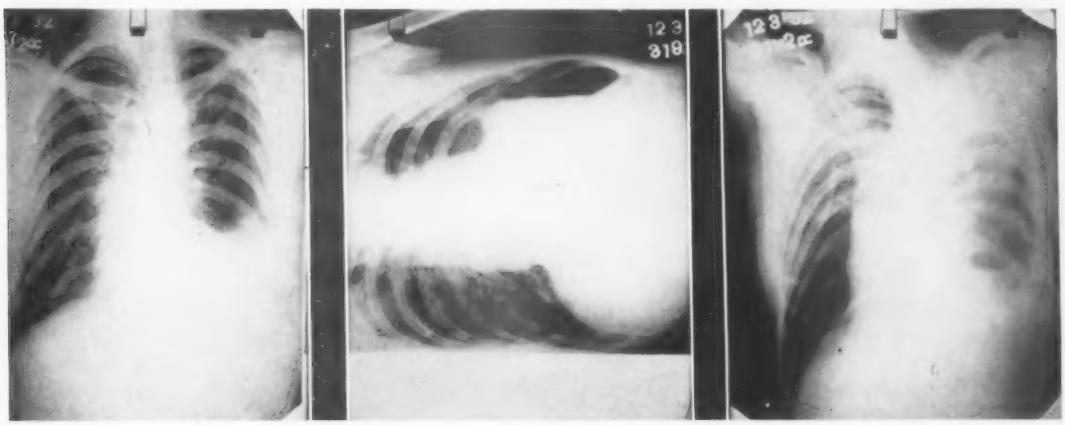

Fig. 2. Case 11. A. Shadow of effusion at left base, its upper border horizontal. No air pocket above, but apparently normal lung. B. Taken at same time as A. Note the air bubble in lower axilla. C. Taken in knee chest position, at same time as A and B. Note the air in the complemental space, displacing diaphragm and abdominal viscera inward. The lower and outer borders of the adherent upper lobe are well outlined.

wave. Upon bending the patient over to the right an air space was uncovered above the fluid in the left axilla (see Fig. 2).

Paracentesis produced serosanguinous fluid with hemoglobin content of 5 per cent. Several aspirations were done. In two months the lung was fully expanded but there were extensive pleural adhesions.

SUMMARY AND CONCLUSION

1. The interesting roentgen findings described by Yater and Rodis were caused by hydropneumothorax. The air pocket was obscured by partly expanded and adherent lung.

2. In patients with hydropneumothorax who are confined to bed, the upper lobe expands early and comes in contact with the chest wall while the lower (posterior) lobe remains separated from the chest wall by air and fluid. A roentgenographic examination in the erect position may fail to demonstrate the air bubble in such a case.

3. An examination in lateral recumbency, with the patient lying on the well side, will show the true state of affairs, bringing into view the air bubble above the fluid level, in a region of the chest free of the adherent upper lobe, i.e., in the lower axillary region of the affected side.

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THE REËXPANDED LUNG

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THE roentgenological appearance of the lung after treatment by artificial pneumothorax is a subject of great interest. Its study is, unfortunately, too often made difficult because of the pleural thickening overshadowing the pulmonary field.

BONY THORAX

In old cases the entire hemithorax is depressed, the interspaces being sometimes markedly narrowed and the intercostal muscles somewhat atrophied and drawn in. This phenomenon appears often before the institution of pneumothorax. We all know those chronic tuberculous patients who have one side of the thorax flattened and depressed even to the point of bringing the shoulder down and of producing a scoliosis. That same condition is present to a lesser degree during the earlier stages of unilateral disease, as well as during and after pneumothorax, but it results from different factors. Before pneumothorax it is a manifestation of the well-known physiological effort of nature to keep an affected organ at rest.

During the period of inflation a principle of physics enters into action. The intrapleural pressure decreasing with every respiratory motion and producing a relative vacuum tends to limit the thoracic expansion and to draw a little on the soft tissues covering the bony cage. This slight pull, repeated hundreds of times every day during several years, is capable of producing marked changes.

FIG. 1. Case 1. August 6, 1931. Pneumothorax on the left for two and a half years. Note depression of left hemithorax and displacement of mediastinum. Right lung breaking down; cavity above interlobar fissure.

FIG. 2. Case 1. August 21, 1931. Good selective collapse.

When the lung has come back to the chest wall, obliteration of the pleural space occurs and we have an organized and fibrotic pleura attached to a fibrotic and puckered lung, preventing the already depressed thorax from resuming its normal shape. This last condition is merely mechanical.

I have taken for granted, however, that we were dealing with a fibrocaseous type of lesion. In the case of an early infiltration the second phase only of the process will

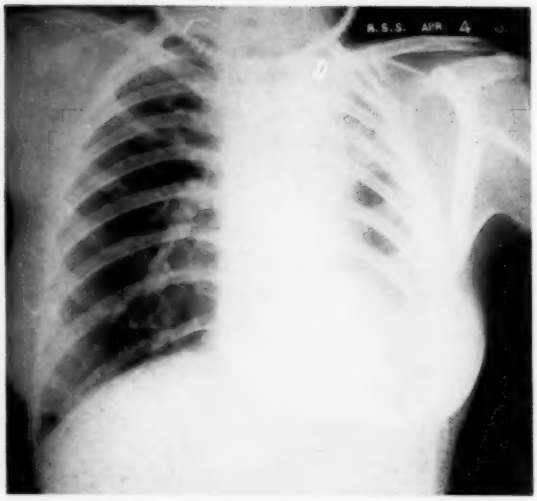

FIG. 3. Case 1. April, 1934. Complete clearing after three and a half years of collapse—restitutio in integrum.

appear and the hemithorax will resume its normal shape and function at the end of the treatment providing the pleura has remained free from serious complications (Fig. 3).

THE PLEURA

The pleura, however, seldom comes out of artificial pneumothorax without some complications, the great majority of which are fortunately not severe. Pneumothorax is responsible only as a determining factor in causing fluid. The fact that adhesions are seen in most cases proves that a pathological process was already present.

A certain degree of thickening usually takes place. It seems to be greater whenever abundant and prolonged effusions are present. A good deal depends, however, on the quality of the fluid and on its percentage of fibrin. In final analysis the extent and the nature of the pleural reaction remain in a large degree an unknown quantity.

After the resorption of fluid some mobile masses of various sizes and shapes are occasionally seen. These are usually considered as fibrinous bodies.

Guesswork also is the estimation of the presence or absence of fluid after reëxpansion of a hydropneumothorax. Whether we are dealing with fluid or with a thickened pleura, the film will show the same homogeneous shadow in both instances. The differential diagnosis is rendered all the more difficult by the frequent combination of both effusion and thickening.

THE MEDIASTINUM

The mediastinum is subjected to different and usually opposite actions during and after pneumothorax. With a free pleura the pneumothorax has a tendency to push it towards the opposite side. But as soon as the lung has been allowed to come in contact with the outer wall, conditions change entirely. The bony thorax becomes a fixed point of attachment for the agglutinated pleural layers and a complete and continuous bridging of fibrosis is established between the thorax and the softer and more flexible mediastinal structures. These are pulled outward and contribute their share in filling in the gaps left by the loss of substance in the pulmonary tissue located between those two points. The displacement of the mediastinum is mostly marked at the level of the main lesions, which are so frequently located immediately above the interlobar fissure. The latter plays the part of a strong tie running in an almost straight line from the chest wall to the mediastinum where it is attached. Its location explains the pronounced displacement of the trachea (Figs. 7 and 9). But the mediastinum may also be drawn in its whole length and produce a complete dextrocardia (Fig. 10). The successive phases of such a shifting are interesting to follow in case of progressing obliteration starting on the diaphragm and creeping upward along the outer chest wall. The mediastinal displacements do not follow a lateral direction only, but also an anteroposterior one according to the location of the retracting force (Fig. 4).

THE LUNG

The condition of the lung after reëxpansion depends a great deal on its condition before collapse. It is influenced more by

the nature of the lesions than by their extension. The patches of recent infiltration surrounded by their customary fuzzy area of exudation disappear completely from the picture, leaving a clear lung.

Annular shadows outlining the site of cavities in the process of formation also vanish from the film. Because of this complete disappearance, sometimes on bed treatment alone, some clinicians have felt that these ring shadows were not in the parenchyma but on the pleura, and have refused to consider any of them as cavities unless they showed a fluid level and increased illumination in their center. As a matter of fact, neither the fluid level nor the increased illumination is of any aid as both may be present in pleural blebs just as well as in pulmonary cavities. The first insufflations of pneumothorax have almost invariably proved that such shadows were beginning cavities by accentuating their contour instead of making them disappear as in the case of a pleural pocket and by displacing them with the partly collapsed lung.

Fig. 4. Case II. Upper lobe bronchiectasis. Lateral film taken after injection of lipiodol shows that the main dilatations are located anteriorly to the mediastinal structures which are drawn towards the sternum.

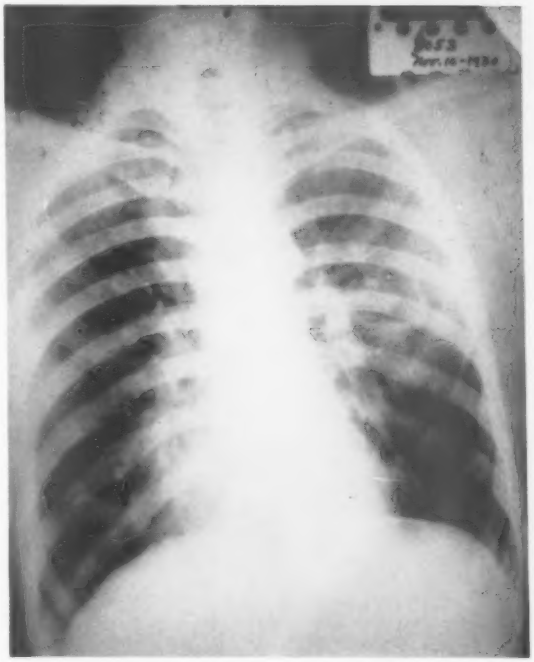

Fig. 5. Case III. Large cavity with fluid level and rather thin wall in center of left lung.

The principles of tuberculosis pathology and the various processes of infiltration should be borne in mind. The word cavity immediately brings up the picture of a sizable hole in the lung tissue with its usual loss of substance, its anfractuous walls and a more or less considerable accumulation of débris in its dependent portions. Then we can explain to our great comfort and satisfaction the ring, the increased illumination and the fluid level. But we should not lose sight of the fact that such destruction did not take place overnight. A few weeks or a few months before the ring shadow would have been thinner and more difficult to visualize because of the absence of fibrosis. Another retrograding step would take us to the time when that same shadow was barely visible. At that time epithelial cells, giant cells, lymphocytes, fibroblasts encircling by as many lines of defense the recently infiltrated area accounted for the ring shadow. Necrosis and elimination had not yet taken place. Consequently, the area within the ring was not excavated and

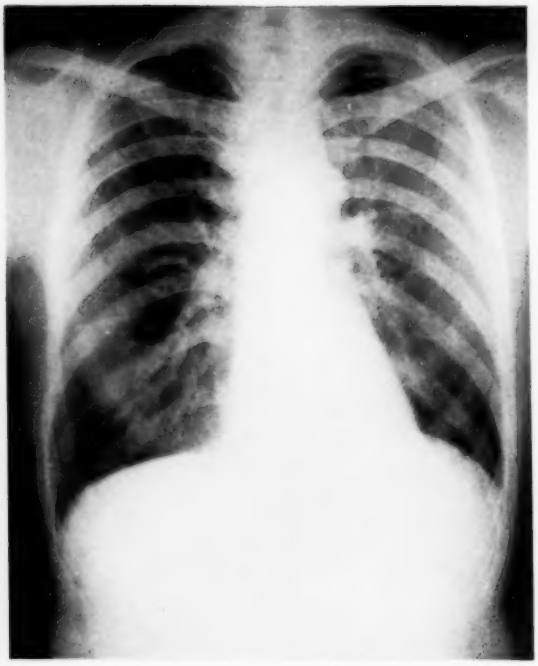

Fig. 6. Case III. After only a few months of a rather poor collapse prematurely given up by patient himself, the cavity had entirely disappeared leaving no visible traces.

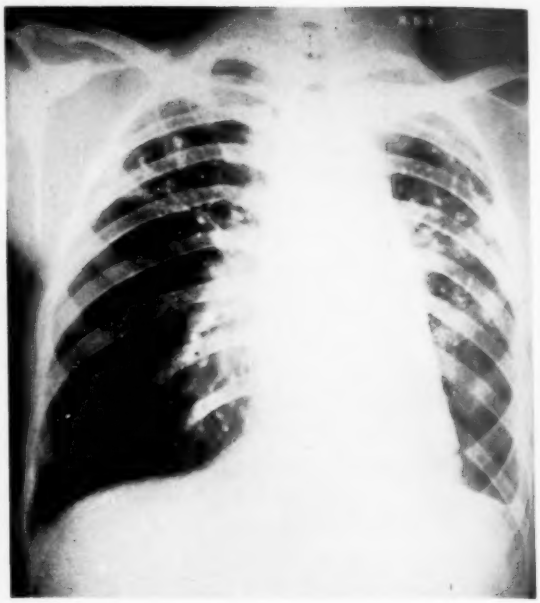

Fig. 7. Case IV. Numerous calcifications and displacement of entire mediastinum, especially at level of interlobar fissure. Lung field fairly clear. Left lung had been under collapse for two years.

could not light up more than the surrounding portions. On the contrary, it might have been denser because of exudation.

This type of beginning cavitation, healing by resolution, disappears completely and leaves no trace whatsoever on the film.

In case of actual excavation, the process is one of repair and scars will remain to be seen. The smallest cavities and the small caseous formations often heal up by calcification. Calcified nodules are very frequently seen in the reëxpanded lung (Fig. 7). The large excavations fill up by approximation of the walls and more or less at the expense of the surrounding tissue which often shows a condition similar to emphysema but appears thinner and darker.

The streamers and the bands retracting the walls and the edges contribute to the formation of the densities which now occupy the very spots where increased illumination was noted before. Those densities assume vaguely the shape of the cavity but instead of being circular they often appear as oblong as a result of the traction exerted by the pleura (Figs. 8 and 9). One is often surprised, however, to see the marvels that the repairing process some-

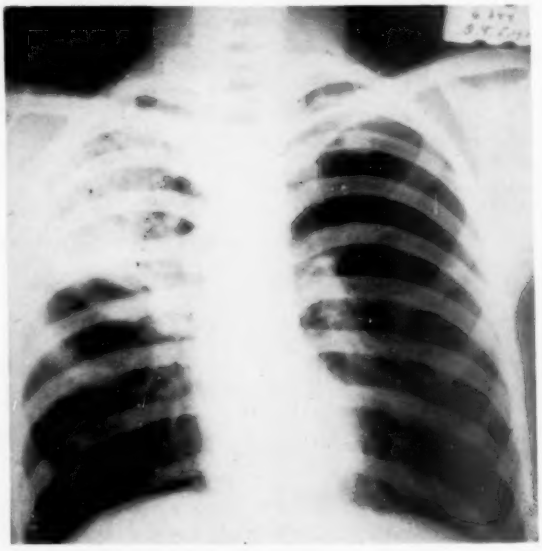

Fig. 8. Case V. Multiple cavitations and considerable exudation of right upper lobe.

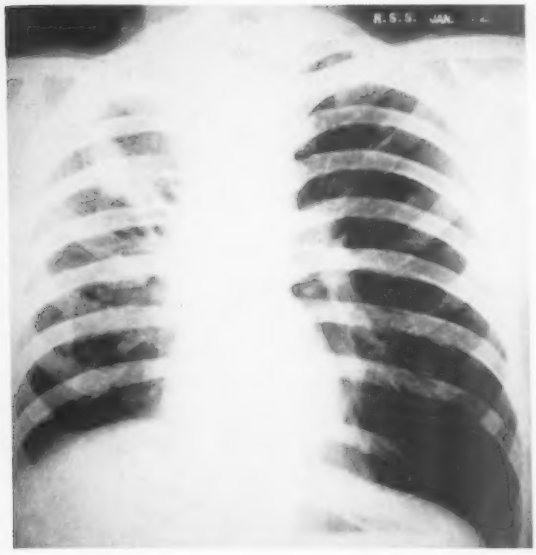

Fig. 9. Case v. After pneumothorax. Note oblong dense shadow in upper part of second interspace where the largest cavity was seen in previous film. There is mediastinal displacement and narrowing of the interspaces. Veil over apex probably due in part to atelectasis, in part to fibrosis.

Fig. 11. Case vii. Film taken in July, 1930, showing initial lesion on the right and a fairly good left lung. Right lung was collapsed and patient doing very well. Sputum was scanty and negative. After thirteen months patient left sanatorium against advice.

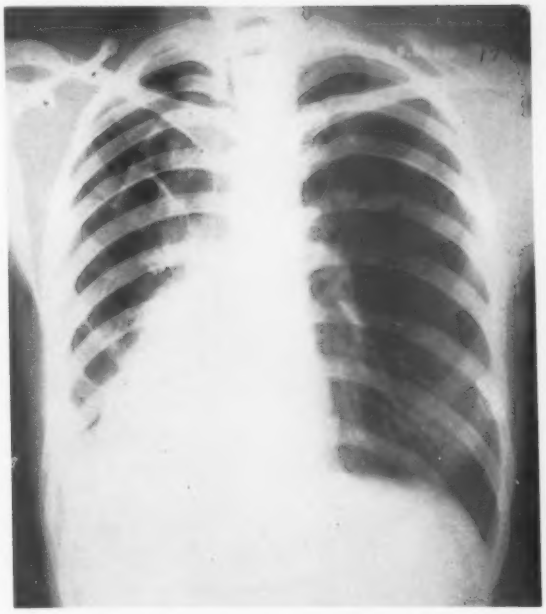

Fig. 10. Case vi. Complete dextrocardia after seven years of collapse. Hypertrophy of left lung. No discomfort to patient who is well and working.

times accomplishes and to find very few or no traces of pathology where large cavities with fluid level were present (Figs. 1, 2, 3, 5 and 6).

A striking feature brought out by a

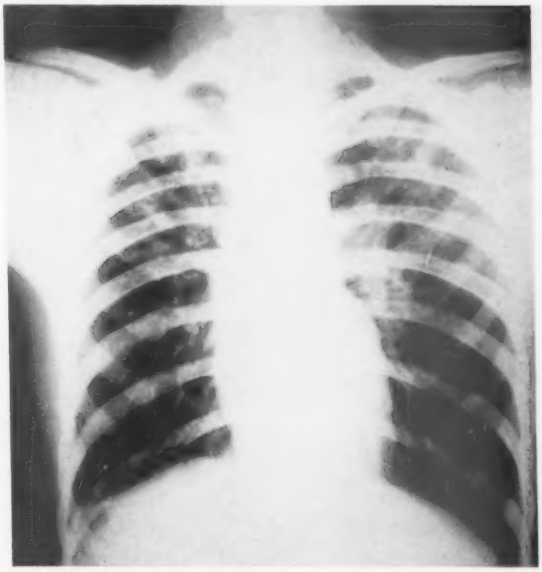

Fig. 12. Case vii. Two years later. Lesions have reappeared on the right. Left lung also breaking down.

recent study of a fairly large number of reëxpanded pneumothoraces was the frequent breaking down of the old lesions (Figs. 11 and 12). Tuberculosis progresses slowly and heals just as slowly. The time element should never be forgotten in all our dealings with it. It is better to maintain the collapses a year longer than might be necessary than to abandon them a month too soon. Three years does not seem too long to keep a collapse instituted for an exudative lesion in a young individual, and six to seven years for an ulcerocaseous process.

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THE DANGERS OF ROENTGENOSCOPY AND METHODS OF PROTECTION AGAINST THEM

V. SOME CONSIDERATIONS OF THE "DOSE" RECEIVED DURING EXAMINATION OF THE COLON*

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PREVIOUSLY we have reported our determinations of the dose received by the operator's hand in the course of routine roentgenoscopic examination of stomachs. After these determinations had been made, we turned our attention to examination of colons. During this procedure a larger beam of roentgen rays is used throughout, and the thickness of the body is greater; at the level of the anterior superior spines, and at the level of the umbilicus, the body is about 23 cm. thick.

The actual technique of roentgenoscopic examination of the colon has been discussed in detail elsewhere. We will refer, in this paper, only to those portions of the technique which apply specifically to the problem of dose received by the examiner. The roentgenoscopist steps behind a lead screen when he makes exposures. Roentgenograms of the colon are made with the patient on the roentgenoscopic table, by the use of a "heavy duty" tube suspended in an enclosing lead-glass holder. Other roentgenograms are made by technicians in other rooms. Two rooms are used for examination of the colon; a patient is prepared in one room, while examination of another patient progresses in the other room. An electric integrating time clock in the primary circuit of the roentgen-ray machine, activated by the foot switch, demonstrated, in countless examinations, that an average of two and a half minutes of actual activation of the roentgen tube is required for each colon examined. The only protective device used by the examiner is a leather driving glove, such as is used in gastric roentgenoscopy.

In practice, the examiner controls the shutter and tube with one hand, and turns the patient and palpates with the other hand. The palpating hand is thus in the direct beam about half of the time, the rest of the time it is at some distance from the beam, usually at the level of the thigh or buttock, turning the patient. Deep palpation for elicitation of mucosal relief is attempted in all cases, and when this part of the procedure is finished the examiner straightens out coils of intestine and attempts to approximate the walls of a questionable portion of the bowel.

The barium-filled bowel appears to be about the equivalent of the stomach in filtering power, to judge by our studies. Moreover, the barium-filled rectum and coils of the sigmoid offer great protection for a considerable portion of the examination as is the case with the stomach.

The doses received in examination of the colon were determined as follows: The remodeled phantom was 23 cm. thick. Extending across it was a model colon, 5 cm. each in breadth and in depth, with rounded corners. The model colon lay in the phantom at a depth of 7 cm. (Fig. 1).

The roentgenoscopic table used for examination of colons differs structurally from the vertical roentgenoscope only in the addition of a pad, about 1½ inch (4 cm.) thick, covered with rubber sheeting

* Abstract of thesis submitted by Dr. Cilley to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology.

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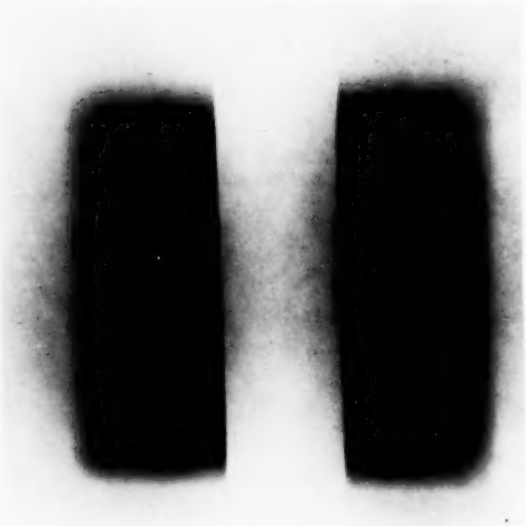

FIG. 1. Roentgenogram of the model colon constructed in the 23 cm. phantom.

on which the patient lies. Addition of this pad increases the time required for delivery of 400 r, from twelve minutes and forty-eight seconds, for the vertical roentgenoscopic outfit, to fourteen minutes and eight seconds. The wax phantom was placed on the table and the routine machine settings were used (85 kv. p., 5 ma.). Colons are actually examined with a tube current of 2.5 to 4 ma.; however, the higher milliamperage we used facilitates measurements and the difference in intensity thus produced is easily calculated. Measurements were made with the large (500 c.c.) and small (2 c.c.) ionization chambers of the Victoreen roentgenometer in a number of positions. Since, for all routine purposes of examination, a 20 cm. square beam is used, the radiation in the shadow of the model colon, and to the side of the shadow, was measured, and was found to be 0.353 per cent and 0.689 per cent, respectively, of the dose delivered to the phantom. The palpatory procedures occupy perhaps half of the time the hand is engaged in palpation; the rest of the time is spent straightening out the sigmoid and examining the cecum, with the hand largely shielded by the barium in the sigmoid and rectum; very little radiation reaches the hand. To verify this, a 5 cm. beam was used and the resulting depth dose, measured on the surface of the abdomen was found to be 0.184 per cent (Fig. 2).

From these measurements we concluded that, during the 150 seconds consumed in examining the average colon, seventy-five seconds are spent with the hand turning the patient. During these seconds, the hand receives less than 0.013 per cent of the primary radiation; of the remaining time, 37.5 seconds are spent with the hand receiving 0.521 per cent of the primary radiation which reaches the patient's back (average of 0.353 per cent and 0.689 per cent), and in the 37.5 seconds still remaining the hand receives 0.184 per cent of the primary radiation which reaches the pa-

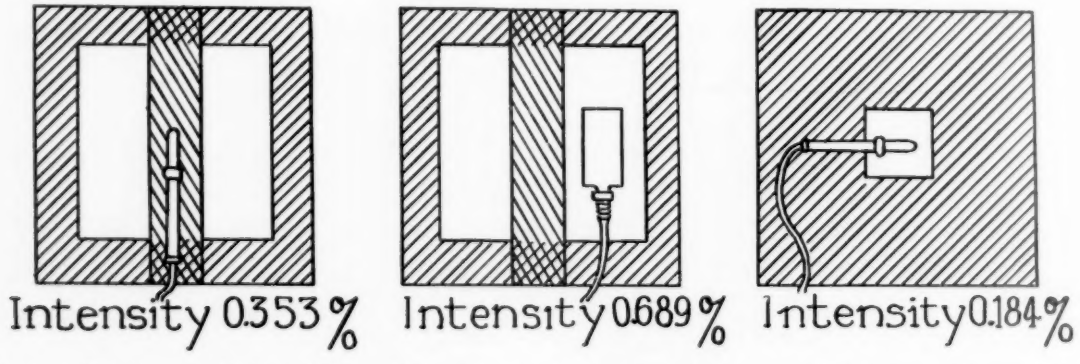

FIG. 2. Relative positions of the model colon, the ionization chambers and the roentgen-ray beam in making the measurements about the 23 cm. phantom, from which the exposure received by the hand during palpation of the colon was estimated.

tient's back. This amounts to an average exposure of the hand during the 2.5 minutes of examination of 0.184 per cent of the radiation that reaches the patient's back (Table 1).

TABLE I
COMPUTATION OF AVERAGE EXPOSURE BASED ON 5 MA. TUBE CURRENT

Use or Position of Hand	Dose Received by Examiner's Hand, Per Cent*	Time of Examination, Seconds
Turning patient	0.013	75.0
Palpating colon	0.521	37.5
Region of sigmoid and rectum	0.181	37.5
Average exposure per examination	0.184 per cent of dose to back 0.0325 per cent S.E.D.	

* The value given is a percentage of the dose which reaches the patient's back.

In order to calculate the exposure received in terms of the erythema dose (400 r) received per minute and per examination, the percentage of an erythema dose delivered to the patient's back in one minute and in two and a half minutes of exposure was found to be 7.07 per cent and 17.67 per cent of an S.E.D. respectively. The operator's hand received 0.184 per cent of this dose or 0.0130 per cent of an S.E.D. for each minute of the examination and 0.0325 per cent of an erythema dose for each examination. This does not tell the whole story, however, since it is the present custom of one of the men who examine colons to work with a 3 ma. tube current and of another to work with 4 ma. This change in current reduces the dose received by these men to 0.0195 per cent S.E.D. and 0.026 per cent S.E.D. per examination respectively.

Three men have examined most of the colons over a period of thirteen years. A examined colons from 1921 to 1926. During this period 24,340 colons were examined at the Clinic, so that, crediting him with 17,120 examinations, as we have done, is probably a slight under-estimation of the actual number.

We are unable to consider in detail the factors governing the exposure this man received, but we feel reasonably sure that he exposed himself to more radiation per minute of examination than the other men who followed him on the service. We shall estimate the dose he received on the basis of B's films, and the secondary radiation measurements made with the phantom. Photographically measured, A's hand probably received a gross exposure of 1.71 S.E.D.; an average yearly exposure of 28.5 per cent S.E.D.; a high yearly exposure of 39.8 per cent S.E.D.; an exposure in a peak month, of 5 per cent S.E.D., and an exposure in a least busy month of around 3 per cent S.E.D. From scattering, judging from B's films, A received, on his trunk and thighs, an average exposure about as follows: 26.4 per cent S.E.D., gross exposure over the six years; 5.2 per cent S.E.D., average yearly exposure; 6.7 per cent S.E.D. for his peak year; 0.62 per cent S.E.D., for his peak month, and 0.39 per cent S.E.D. for his least busy month.

On the basis of scattering from the phantom, he received, at from 3 to 4 feet (91 to 122 cm.) from the floor and 6 inches (15 cm.) from the edge of the table, an average of 0.00028 S.E.D., or one Barclay daily "tolerance dose" per average two and a half minutes' examination. During these six years he received about 17,120 tolerance doses with a peak month of 560 tolerance doses and a least busy month of 200 tolerance doses without sustaining any evident injury.

B started to examine colons in July, 1927, and made several examinations each day for the rest of that year, with the exception of a period of six weeks in which he did them all. In the first six months of 1928 he examined half of the colons referred to the section for examination. From July, 1928, to January, 1931, he made all the examinations of colons with the exception of four each day. He was present even

at these four examinations, and received some radiation in the course of them. From January, 1931, to the present time, he has examined colons every other week, examining all but four each day during this time; this makes a grand total of 16,785 examinations.* On the basis of the photographic measurements, his hand received a gross exposure of 1.67 S.E.D.; an average yearly exposure of 27.8 per cent S.E.D.; exposure in a peak year of 47.3 per cent S.E.D.; exposure in a least busy year of 5 per cent S.E.D., and exposure in a peak month of 5.43 per cent S.E.D. On many days, during the rush season, he examined more than the fifteen colons required to produce a dosage of 0.15 per cent S.E.D., or 5^+ daily Barclay tolerance doses. On the basis of an average day, with six colons examined, his hand received approximately two tolerance doses; that is, a little more than a tolerance dose according to Barclay, but a little less according to Glocker. On the basis of our measurements with the ionization chamber carried on with the wax phantom, the hand should receive somewhat more than three times the dosage that measurements by photographic methods indicate. This would raise the large daily dose to 15^+ tolerance doses, and the ordinary daily dose to 6^+ tolerance doses.

On the basis of photographic measurements, taking the average of the group of films worn affixed to the trunk as the dosage received, which amounts to 80 per cent of the dosage indicated by the blackest film worn, as our basis of measurement, this amounts to 132.10^{-7} S.E.D. per examination received by B's body. B, therefore, received a gross exposure to his body of 22.1 per cent S.E.D.; a yearly average exposure of 3 per cent S.E.D., an exposure of 0.7 per cent S.E.D., in a peak month, and an exposure of 0.3 per cent S.E.D. in a slack month. On an average day, examining six colons, he received 27 per cent of the Barclay or Mutscheller tolerance dose and on a busy day, examining fifteen colons, he received 58.5 per cent of the tolerance dose.

These dosages are not strictly accurate, since B gets an additional gross exposure in the course of four examinations a day from his standing about 24 inches to the head of his regular position. From our measurements with the ionization chamber we determined that in this position about a third of the radiation opposite the center of the beam is received. That this value may not apply when a patient replaces the phantom is probable, since the intensity of scattered radiation is very different with alteration of any of the factors. It is even possible that the doctor receives a greater dose in this position than when he is examining patients. In any case scattered radiation adds an appreciable amount to the calculated exposure. On the basis of measurements made by the ionization chamber, opposite the center of the phantom, B receives one Barclay tolerance dose per examination and an additional tolerance dose for each of four examinations, or seven tolerance doses on a busy day. This amounts to a gross dosage from scattered rays of 16,785 tolerance doses received over the period of six years or 2,934 tolerance doses per average year (Tables II and III). Yet no evidence of any injurious effect has been noticed.

A had a more uniform exposure than B. In his least busy year he examined 2,022 patients, as compared to 500 examined by B; on the other hand, A in his peak year, examined 3,985 patients as opposed to 4,736 examined by B. Their average per year, for the period of six years during which each has worked to date, is very close, A exceeding B by only 51 cases per year.

We attempted, in a number of ways, to correlate our measurements made by film and ionization chamber, and we found the films apparently more sensitive throughout when directly compared. We feel that our film system must be accurate within 40 per cent at least. The ionization measure-

* Actually he has examined at least one-third more patients than this figure indicates according to his own estimate.

ments check very well, considering the differences in technique employed, with the results of other published reports.

C, working one year, examined 1,680 colons, and on this basis exposed his palm to a total of 16.8 per cent S.E.D. He worked

TABLE II

DISTRIBUTION OF EXAMINATIONS OF THE COLON OVER THE PERIOD OF TWELVE YEARS, 1921–1932

Year	Total	Colons Examined				
		A	B	C	D	Other Examiners
1921	3,222	2,022				1,200
1922	3,442	2,222				1,200
1923	4,109	2,909				1,200
1924	3,898	2,698				1,200
1925	4,484	3,284				1,200
1926	5,185	3,985				1,200
1927	5,328		500			4,828
1928	5,725		4,525			1,200
1929	5,936		4,736			1,200
1930	5,457		4,257			1,200
1931	4,560		1,680	1,680		1,200
1932	3,374		1,087		1,087	1,200
Total	54,720	17,120	16,785	1,680	1,087	18,028
Average per year		2,853	2,784	1,680	1,087	

TABLE III

DETAILS OF THE DOSAGE RECEIVED BY B

Part Exposed	Method of Measurement	Total S.E.D.	Dosage in Per Cent S.E.D.			Dosage in Terms of 5 r per Month; Tolerance Dose as Unity			Dosage, Considering Barclay's Daily Tolerance Dose as Unity	
			Peak Year	Average Year	Least Busy Year	Peak Month	Average Month	Least Busy Month	Peak Day	Average Day
Hand	Photographic*	1.67	47.3	27.8	5.0	6.2	2.78	1.3	5.3	3.2
Trunk	Photographic	0.22	6.2	3.6	0.6	87.2	36.7	17.2	70.7	42.4
Trunk*	Phantom and ionization chamber	3.9	110.0	64.9	12.7	10.3	4.34	2.0	15.0	9.0
Hand†	Phantom and ionization chamber	2.43	68.6	40.3	7.2	6.4	2.68	1.2	7.7	4.6

Four examinations of the colon each day at which Dr. B is present, expose his trunk to the equivalent of one additional examination.

* Based on 2.5 ma. and a 20 cm. beam. The milliamperage varies between 2.5 and 3: 3 ma. adds 1/5 to each figure, a negligible amount.

† Exposure of the hand is computed on the basis of 2.5 ma. Since we calculate 400 r = 1 S.E.D., with our ionization chamber our results are 1/3 lower than if we considered 600 r as our S.E.D. The photographic measurements, here as elsewhere, rest on the basis of 615 r as an S.E.D.

every other week and received daily exposures comparable to, and probably a little greater than, those received by B. The total dosage received by B corresponds closely to that received by C.

The dose received by D was so small that comment concerning him is not required.

SUMMARY

Data are presented to show that in roentgenoscopic examination of the colon, just as in roentgenoscopic examination of the stomach, multiples of the so-called tolerance doses have been sustained by the examiners, with apparent impunity. The importance of speed of examination, utilization of protective power of the barium-filled viscus, and use of the smallest possible beam are self-evident from this study, if injuries are to be minimized. An ionization method and a photographic method of measurement of the doses received led to results that we cannot reconcile with each other; both methods have advantages and inherent errors. From this study, as from those already reported, we advocate no change whatever in the accepted methods of protection.

Vol. 33, No. 6

CONSIDERATIONS RELATIVE TO THE EVALUATION OF ULTRAVIOLET RADIATION IN ABSOLUTE UNITS

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I. INTRODUCTION

IN THE deliberations of the Second international Congress on Light, which met in Copenhagen in August, 1932, it was abundantly shown[1] that the evaluation of ultraviolet radiation, for use in medicine, should be based upon phenomena that are reproducible, independent of the observer and the instruments used in making the determinations, and should not require special means for correlating the physical measurement with the biological effect.[14]

Without desiring to disparage the accomplishments of the pioneers in this work, a survey of the various photochemical and photoelectric instruments, used in making ultraviolet measurements, showed that none meet the above-enumerated requirements, and that, as a result, but little of this earlier work could be reproduced quantitatively if it were attempted.

Hence, realizing the importance of reproducibility of experimental conditions and observational work, after due deliberation of the subject, the International Committee on Measurement and Standardization of Ultraviolet Radiation for Use in Medicine recommended the evaluation of ultraviolet radiation stimuli by means of physical (radiometric) instruments in absolute units, leaving for the future the correlation of the physical measurements with the biological and physiological (for example, the erythemal) reactions.

Of course there were some who hesitated and demurred at taking this step, which, in my opinion, was the only logical procedure at this time. However, if in the future, order will come out of the present chaos as the result of the wholehearted adoption of these recommendations, it will be owing to the farsightedness of vitally interested physiologists and physicians who assumed the leadership in promulgating the procedure recommended at the Copenhagen meeting.

The usefulness of a biological evaluation is not to be overlooked and at the proposed international congress, which is scheduled to meet in 1936, this phase of the question of the use of ultraviolet radiation should be given due consideration. In the meantime, however, it should not be overlooked that the trend is to evaluate photochemical, physiological and biological reactions on an energy basis, in absolute value.

The reason for this is because the energy evaluation of the radiation stimulus is definite and reproducible. In contrast, the various reactions (e.g., photochemical, erythemic, etc.) to radiant energy are complex and generally are not proportional to the intensity. For example, the quantum yield in the photolysis of gaseous acetone[2] depends upon various factors, including the pressure of the gas and the intensity of the incident radiation,—the quantum yield increasing with decrease in intensity. Hence, the reverse process of using the photochemical reaction (acetone, methylene blue, etc.) as a measure of the intensity of ultraviolet radiation is subject to numerous uncertainties that require investigation.

The photobiological reactions, which occupy the present-day attention, are even less understood than the reactions which can be analyzed photochemically. Among these reactions are the healing of rickets (by exposure of the body to short wave length ultraviolet radiation and by internal medication with irradiated oils and

* Member of the International Committee on the Measurement and Standardization of Ultraviolet Used in Medicine. Discussion presented to the Committee at their Meeting in Zurich, July, 1934.

foods), the curing of cutaneous diseases (for example, lupus) and the production of an erythema.

Of the various physiological and biological reactions in which we are especially interested, the spectral erythemic reaction of the untanned skin has been given the most systematic investigation.

It is true that thus far observations have been made upon only a small number of persons of average pigmentation. However, judging from a study[3] of the spectral visibility response of a large group of persons (130 in all) of various limitations of color perception (color blind, red sensitive, green sensitive, blue sensitive) in which the spectral visibility response curve of the heterogeneous group is not conspicuously different from that of a limited number of persons of average color sensibility; also, judging from erythemic reaction tests of Ellinger[4] on 1,200 persons exposed to the total ultraviolet radiation from a high temperature, high vapor pressure quartz mercury arc lamp, and from the spectral erythemic observations of Saidman[5] using filters which separate the effect of the quartz mercury arc radiation of the wave lengths at 2,537 Å from the effect of the radiation at 2,967 Å, it appears that unless observations are made on a very extensive group of sick and well persons, of brunettes and blondes, also of persons who do not pigment at all, and those who pigment readily, the research will contribute but little beyond what we already know, and that only by the examination of a very extensive heterogeneous group can the data be compared with the observations, on healthy persons of average skin pigmentation, now in use.[6]

By this assertion is meant that, after all that may be said and done, the fact will remain that the logical procedure to safeguard the patient from burns will be to make a series of localized test exposures, upon small areas, to determine the skin tolerance as measured by the erythemal response, before attempting the irradiation of large areas. This applies to all sources emitting appreciable radiation of wave lengths shorter than 3,200 Å, having erythemogenic properties, as distinguished from the beautiful application of the carbon arc lamp by Lomholt[7] at the Finsen Institute, in which (by means of filters of copper ammonium sulphate and cobalt sulphate that completely absorb all wave lengths longer than about 4,000 Å, and a filter of pyrex glass that absorbs the ultraviolet of wave lengths shorter than about 3,200 Å) the radiation stimulus is confined principally to a band of wave lengths with a maximum intensity in the region of 3,500 Å to 3,600 Å.

From the foregoing it may be seen that the chief usefulness in rating ultraviolet lamps in terms of their erythemogenic power is because of the ease and simplicity in determining (by physical means) the approximate time of exposure for producing a minimum perceptible erythema upon the untanned skin of average pigmentation, thus, on the one hand, avoiding severe burns, and, on the other hand, preventing the fraudulent sale of lamps that emit little or no short wave length ultraviolet radiation.

This is the viewpoint and the basis upon which the Council on Physical Therapy of the American Medical Association accepts ultraviolet lamps,[8] and is entirely separate from the question of whether the lamps cure disease. For if one would believe the claims of the advertiser, judging from the list of ailments enumerated, there are but few diseases that will not be alleviated if not cured by ultraviolet rays.

To recapitulate, erythema is not a measure of the curative power of a lamp. But, so long as the present types of lamps remain in use, a knowledge of skin tolerance, as measured by the erythemal reaction, is a necessity in order to protect the patient from burns.

Moreover, those searching for a biological unit should notice that the use of the erythemal response has unusual possibilities. Like the visual response which (under high intensities) has its maximum at about 5,560 Å, permitting the evaluation

of the standard of luminous intensity in terms of a wave length of homogeneous radiation,[9,10] (at wave length 5,461 Å) the erythemal reaction, with its maximum response close to the wave length 2,967 Å, is easily evaluated,[11,12] in absolute measure in terms of the emission line of the mercury arc, at 2,967 Å.

This emission line is a natural standard, easily reproduced and evaluated radiometrically in the average laboratory.[12] Hence, it is available to all, and can be used as a basis for specifying the erythemogenic output of various sources.[8,12,13] Thus far, no other biological or physiological reaction has been investigated, which under average conditions permits such a simple energy correlation.

In the case of rickets the wave lengths that effect a cure occur in the same spectral band that has the power of generating an erythema. Hence, unless some more suitable, intense, and easily isolated emission line is found, then the emission line of mercury at 2,967 Å might be used as a standard for evaluating the effectiveness of sources of radiation in terms of both the erythema and the antirachitic reaction, particularly since the dosage exposure for healing rickets depends upon skin tolerance to erythema.

This of course is an indirect approach in the search for a biological unit. However, as pointed out by Ponzio,[14] so many factors tend to modify the biological reaction of the different tissues that it lacks in precise control. Hence, the dosimetric evaluation of irradiation by the biological reaction is practically excluded, and for the present should occupy a secondary place until better understood.

Whenever the procedure is possible the use of single wave lengths, as stimuli, in studying physiological and biological reactions, facilitates standardization and reproducibility. Knowing the wave length and the intensity, in absolute measure, of the exciting radiation used by one experimenter, it is possible for another investigator to employ the same method.

For example, by using[12] the wave length 2,967 Å in calibrating the skin sensibility of different persons, and of the same person at different seasons, it was possible to determine experimentally, and by calculation using the spectral erythemic response, the erythemogenic effect of different sources of heterogeneous ultraviolet radiation. It is the first step in an investigation that can be extended indefinitely, anywhere, by anyone, since it does not depend upon an arbitrary standard.

This procedure is in harmony with the effort of scientists to establish natural reproducible standards whenever it is possible. Take, for example, the standard of length, which, after centuries of thought and effort, is finally defined in terms of the wave length of the red cadmium line,—6,438.4,696 Å. In the case of the standard of luminous intensity we still have the arbitrary "candle"; though, as already mentioned, some progress has been made in placing this unit upon an absolute energy basis,[9] by comparing the "standard candle" with the monochromatic green mercury line (5,460.7 Å) which occurs close to the wave length of maximum luminous efficiency.

Researchers are looking forward with renewed interest in the search for a biological unit in phototherapy.[15] My interest in the subject is in providing fundamental instruments[11,12] and methods to form a primary basis for standardization of radiation stimuli in an unassailable, reproducible basis.

Such a standardization will naturally fall to the lot of the National Standardization Institutes, which in turn will be able to standardize simple dosage intensity meters for use in everyday practice in phototherapy.

The need for such a standardization will be apparent to anyone who peruses the ever-increasing literature describing ultraviolet measurements, with photoelectric and photochemical instruments, made on an arbitrary scale that cannot be reproduced; and hence, it is impossible to make intercomparisons by other observers.

As aptly pointed out recently by de Rochemont,[16] fundamental instruments, such as the balanced actinometer,[11,12] are probably too expensive for use by the physician, for whose purposes simple but reliable photoelectric and photochemical dosage meters will be sufficiently accurate. The method of calibrating simple photoelectric[11] and photochemical (the I. G. Farbenindustrie[17]) dosage intensity meters in absolute units is already described. By means of the latter instrument, calibrated in absolute units, I was able to obtain interesting ultraviolet measurements[17] on land and at sea, in my journey to and from the Copenhagen meeting of the International Congress in 1932.

Recently we have made a portable balanced amplifier and photoelectric cell outfit which can be used for precision measurements in the laboratory and in the field.[20]

II. THE EVALUATION OF ULTRAVIOLET RADIATION IN ABSOLUTE UNITS

As already mentioned, an outstanding accomplishment of the International Congress at Copenhagen was the recommendation to evaluate ultraviolet radiation stimuli upon a physical (radiometric) basis in absolute units.

For this purpose the ultraviolet radiation from the source is to be separated into three spectral bands by means of a nonselective radiometer (thermopile) and a series of three standard filters, copies of which are to be maintained at the National Standardizing Institutes of the respective countries interested.

These three spectral bands, A, B, and C, comprise approximately the following wave lengths: A, from 4,000 Å to 3,150 Å; B, from 3,150 Å to 2,800 Å; and C, wave lengths shorter than 2,800 Å.

These three spectral bands comprise the following ranges of biological action: C, germicidal; B, antirachitic and erythemal; A, deeply penetrating ultraviolet radiation, conspicuous in healing certain diseases.[7]

To evaluate these three spectral bands I suggested the use of Pyrex, Barium flint and Noviol-A filters, which, from previous tests, I had found stable in transmission on exposure to ultraviolet radiation. Since then additional glasses, having similar transmissive properties, made by Schott and Genossen, Jena, have been included in the list.

The International Committee on Measurement and Standardization assigned to me the task of procuring the material and of standardizing the first samples for the National Standardizing Institutes. This I have done. Also, since it was overlooked in the original recommendations, I have included a filter of red glass (to give the spectral band between 4,000 Å and 5,500 Å) and a cell of water 1 cm. in thickness, with windows of crystal quartz to be placed permanently over the thermopile to eliminate differences in transmission in these filters for wave lengths longer than 14,000 Å in the infrared. By this means the complete spectrum of a source can be evaluated in a convenient and reproducible manner.

The evaluation in absolute units is easily obtained by measurements on a black body, or by comparison with a Hefner lamp or, preferably, an incandescent lamp standard of radiation[21] which was originally standardized against a black body. In this connection it is relevant to point out the importance of physiologists and physicians keeping in contact with the qualified physicists in their National Standardizing Institutes and Universities, who usually have such apparatus available.

Specification of Filters

For Filter A, Noviol-A, yellow, No. 038, thickness 1.49 to 1.51 mm. (from Corning Glass Works) is used.

For Filter B, use is made of Barium-flint, clear glass (Bur. Standards No. 669, thickness 3.10 mm.); Schott's Jena, Ba-F-4; refractive index $n = 1.605$, thickness to have transmissions given in Table 1.

For Filter C, Corning H. R. clear electrical Pyrex, No. 776, thickness 1.99 to 2.01 mm. is used.

TABLE 1

PER CENT TRANSMISSIONS OF THE STANDARD FILTERS RECOMMENDED BY THE INTERNATIONAL COMMITTEE ON MEASUREMENT AND STANDARDIZATION OF ULTRAVIOLET RADIATION

The intention is to have a transmission of about 55 per cent at 3,130 Å for Pyrex; about 50 per cent at 3,340 for Barium-flint; and about 55 per cent at 4,358 for Noviol-A. The transmissions marked with an asterisk (*) are less than the values given.

Wave length	2,804	2,967	3,022	3,130	3,340	3,650	4,047	4,358	5,461	5,890	6,035	6,200	6,600	7,500
H. R. Pyrex	0.5*	16.5	29	54	78.5	90	91	91.5	—	—	92	—	—	92
Barium flint	0	0	0	0.5*	47.5	82	87.5	88	89	90	—	91	—	91
Noviol-A	0	0	0	0	0	0	0.3*	57	89.5	90	89.5	89	88.5	86
Red Jena R.G. 1	0	0	0	0	0	0	0	0	0	1.5	12.5	71	89.5	91

Red Filter, a high transmission red, Schott's Jena, R. G.-1, (or Corning), thickness 2.0 mm., is used.

Water cell, 1 cm. in thickness, windows of crystalline quartz, 1.5 to 2 mm. in thickness (distilled water) is used.

It is to be noted in Table 1 that the smallest transmission values (less than 1 per cent) given are measurable with some degree of accuracy. This is for the purpose of obtaining the slope of the transmission curve, which would not be possible (without using additional thinner samples) if the end-point in the measured transmission were zero.

From correspondence and inquiries which I have received it appears that the intentions of these recommendations of the International Committee have been misunderstood. For example, one writer pointed out that these filters do not separate the spectrum so as to comprise the same number of wave lengths in each band. It would be practically impossible to accomplish this in practice; and it seems futile to attempt it, for the reason that the spectral energy emitted by any one source and by different sources is entirely different in these spectral bands. It is therefore better, for the present at least, to use the above-mentioned spectral bands, which are recognized as having a biological significance.

However, there appears to be nothing obligatory in these recommendations. For the present at least, the experimental procedure is autonomous. The main thing is to have the evaluation of a given spectral band defined by a filter that is reproducible by other investigators. Hence, if in a certain research it is found desirable to evaluate a spectral band that is different from the recommended bands, A, B, or C, there should be no objection if a reproducible and easily procurable filter is used.

Another question brought to my attention is the manner of use of the filters. In the case where the thermopile consists of a single receiver (covered with the water cell) successive parts of the spectrum are absorbed by insertion of filter A, B, or C, and the change in the galvanometer deflection noted.

On the other hand, when a balanced thermopile (covered with a water cell) is used,[11] it is preferable to cover simultaneously one receiver with the filter (e.g., Barium-flint) and the other receiver with a thin piece of Corex-A glass (or crystal quartz) which balances the loss by reflection in the long wave lengths and readily transmits the short wave length ultraviolet intercepted by the filter. A plate of crystal quartz is better than Corex-A glass for a balancing filter when measuring sources of ultraviolet that emit radiation of wave lengths shorter than 2,800 Å.

In all cases it is necessary to know, with some degree of accuracy, the short wave length (shorter than 4,000 Å) spectral energy distribution of the source, in relative units, which is not difficult to obtain from an artificial source. This is for the purpose of obtaining factors, "F," for the

exact evaluation of the energy in the spectral bands, A, B, and C.

In the case of the sun the spectral energy curve in the ultraviolet is not well known, and should be determined approximately at the time of making the observations. From the close agreement between the radiometric and physiologic (erythemal) evaluation[12,13] it would appear that the errors involved in this method are not so large and not so objectionable as supposed by some writers.

Accuracy of the Filter Method. During the past two years there have been a number of opportunities to test the accuracy of the filter method in evaluating the ultraviolet emitted by various artificial sources, sold for therapeutic purposes.

In one investigation[18] seven research laboratories, including the National Bureau of Standards, participated in an evaluation, in absolute units, of the ultraviolet emission lines of a set of quartz mercury arc lamps, which were interchanged between the various laboratories. The measurements of all the laboratories were found in good agreement.

In the Bureau of Standards I used two methods for evaluating the ultraviolet from the lamps: the spectroradiometric method, as used in other laboratories, and the balanced actinometer and filter radiometer.[11,12] In all cases the integrated ultraviolet, as observed by means of the filter method, was found in good agreement with the summation of the radiation in the individual spectral lines, as measured with the spectroradiometer.

Other tests on the accuracy of the filter method were obtained in connection with the acceptance of ultraviolet lamps by the Council on Physical Therapy[8] of the American Medical Association. Following the recommendations of the International Committee, the Council on Physical Therapy[8] requires manufacturers of the various kinds of ultraviolet lamps to state the ultraviolet output of the lamp, and the approximate time to produce a minimum perceptible erythema.

When samples of these lamps are submitted to the Council on Physical Therapy for acceptance, it requires but a short time to measure the ultraviolet output (of wave lengths shorter than and including 3,130 Å) by means of the Barium-flint glass filter, and to calculate the time to produce a minimum perceptible erythema.[12,13] Usually our measurements are in close agreement with the data supplied by the manufacturer; and, in the few instances where there was a disagreement, the manufacturer accepted our findings in preference to his own.

In this connection it is relevant to note that, in spite of differences in opinion regarding the use of erythema in connection with the sale of ultraviolet lamps, in at least three instances the above-mentioned lamp manufacturer has obtained his erythema standard by observations on a group of workers in his own factory. Nevertheless, there was good agreement between his claims and our tests, which would seem to indicate that, in spite of the great variations noted in erythemic sensibility of different persons, there is no great difficulty in obtaining a reasonably good average value of the erythemal response by a judicious selection of a group of healthy persons of average skin pigmentation, for use as a safeguard in using the lamp. Even with this knowledge, the wise practitioner will test the skin tolerance, by exposure of small areas, before attempting to irradiate large areas of a new patient.

In the present stage of development of this work a certain degree of autonomy in following the recommendations of the International Committee is practically a necessity. Recalling the remonstrances at the Copenhagen meeting that erythema is not a single-valued function and, hence, must not be considered, one would naturally hesitate to consider this physiological reaction in connection with the promiscuous sale of ultraviolet lamps.

In this country, however, the production of ultraviolet lamps of all sorts (some having an ultraviolet output so low that a

continuous exposure of twenty to thirty hours would be required to produce an erythema) increased so rapidly that the Council on Physical Therapy found it desirable to evaluate these lamps in terms of a reaction (erythema) that is easily observable by anyone, and to specify the ultraviolet energy output necessary from the lamp to qualify as a therapeutic agent and for home use[19,8]—the latter specification being necessary to discourage the sale of lamps emitting little or no ultraviolet radiation.

In writing such a specification it is of course necessary to assume a time limit, and a convenient operating distance from the lamp. From an analysis of the data available it was found[19] that a convenient operating distance for portable ultraviolet lamps is 24 inches (61 cm.) from the front edge of the reflector, and that for therapeutic purposes the exposure should not be longer than fifteen minutes.

Although our standardization tests of skin tolerance, using the homogeneous emission line of mercury at 2,967 Å as a source, indicated that about 200,000 ergs per cm.^{2} would be required to produce a minimum perceptible erythema,[12,13] it seemed best to reduce the value to 180,000 ergs per cm.^{2} in order to reduce the danger from possible burns. On this basis, for an exposure of fifteen minutes, a radiant flux intensity of 20 microwatts per cm.^{2} of the wave length 2,967 Å would be required to produce a minimum perceptible erythema.

This forms the basis of the specification of the Council on Physical Therapy for accepting ultraviolet lamps.

From a determination of the spectral energy distribution of each kind of lamp, and the spectral erythemic response,[6] the erythemogenic equivalent of the heterogeneous ultraviolet radiant flux of wave lengths shorter than and including 3,130 Å, is calculated.[12,13] This is the minimum value acceptable by the Council on Physical Therapy. The values for the various kinds of ultraviolet lamps now on the market are given in Table II.

TABLE II

Source	Ultraviolet Intensity in Microwatts per cm.^{2}
Sun: midday, midsummer, midaltitude, sea-level	91
Carbon Arc: blue flame, cored carbon, in reflector, no window	48
Carbon Arc: glass window, opaque to 2,800 Å and shorter (estimated)	90
Mercury Arc: Gen. Elect. Mazda, type S-1 lamp; high temperature arc in parallel with V-shaped tungsten filament	83
Mercury Arc: Gen. Elect. Mazda, type S-2 lamp; similar to the S-1 lamp, but smaller; both in glass bulbs	93
Mercury Arc: Type G-1 and G-5; low temperature, low voltage thermionic glow discharge; glass bulb	108
Mercury Arc: high temperature, high vapor pressure, low voltage; quartz tube	58
Mercury Arc: high frequency electrodeless discharge; quartz bulb	60
Mercury Arc: low temperature, low vapor pressure, high voltage, "cold quartz," Geissler tube discharge	36

Using 20 microwatts per cm.^{2} of homogeneous radiation of wave length 2,967 Å as a standard, the above table gives the erythemogenic equivalent of the heterogeneous (the total integrated) ultraviolet radiation of wave lengths shorter than and including 3,130 Å, required of various sources to produce a minimum perceptible erythema on the average untanned skin in 15 minutes. For an exposure of 60 minutes these values are only one-fourth as large.

As already mentioned, once the ultraviolet spectral energy distribution of a given type of lamp has been determined it is a simple matter to measure the total ultraviolet, of wave lengths shorter than and including 3,130 Å, of a particular lamp, of this type, by means of the balanced thermopile and Barium-flint glass filter, and thus determine whether it is acceptable.

In conclusion, it may be stated that in general the lamps submitted have an intensity that is several times the minimum requirement. In the newer lamps, like the G-type glow lamp, the first productions did not comply with the specifications, but

these lamps were promptly improved to meet competition with the other types.

In general the specifications by the Council have tended to improve the output of responsible lamp manufacturers. But at present there seems to be no means to prevent the exploitation of the public by the sale of cheap lamps emitting little or no ultraviolet radiation.

From the foregoing it may be seen that the activities of the Council on Physical Therapy of the American Medical Association are in keeping, at least in spirit, if not to the exact letter, with the recommendations of the International Committee on Measurement and Standardization of Ultraviolet Used in Medicine.

My object in calling attention to these matters at this time is with the hope that it may stimulate interest in the subject, looking forward to the next meeting of the International Congress, scheduled to meet in Wiesbaden in 1936, when it is to be hoped that these questions can be discussed with a sympathetic understanding of the needs in phototherapy.

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BENIGN LESIONS OF THE EYE, EAR, NOSE AND THROAT*

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RADIUM is a valuable adjunct in the treatment of many inflammatory and neoplastic conditions of the head and neck. Its use in the following lesions will be briefly discussed:

1. Vernal catarrh
2. Hemangioma
3. Polypoid ethmoiditis
4. Fibroma of the nasopharynx
5. Rhinoscleroma
6. Ozena
7. Chronic tonsillitis and chronic lymphoid hyperplasia of the pharynx
8. Tuberculous cervical adenitis
9. Enlarged thymus
10. Leucemia

The dangers and limitations of radium therapy should be clearly understood. The treatments should be carried out under the direction of radium therapists or by otolaryngologists who have made a special study of the physics and biological effects of radium.

In hemangiomas radium exerts a definite specific and selective action on the abnormal endothelial cells lining the blood vessels which make up the tumor process. Pinch, of the Radium Institute, London, makes the following statements regarding vascular tumors:

> Prolonged intensive radiation of blood vessels with radium is productive of proliferation, vacuolation and degeneration of the endothelial cells with leucocytic infiltration of the walls and subsequent destruction of their caliber. If, however, the radiation be of mild degree, acting for a short time at prolonged intervals, multiplication of endothelial cells with increased fibrosis of the vessel wall occurs. These changes result in a definite narrowing, perhaps even obliteration of the smaller vessels, and it is in this fashion that the cure of angiomas is induced.

The majority of angiomas are present at birth or shortly afterwards. The lesions should be treated during the first six months of life, as the walls of the blood vessels become thicker and more organized in the older age groups, and are therefore more refractory to irradiation. The technique of irradiation varies according to the size and location of the lesion. Surface irradiation at 5 to 20 mm. may be employed depending upon the thickness of the lesion. Interstitial irradiation with gold radon implants or platinum radium needles is another method of treatment.

In polypoid ethmoiditis radium has been used as an effective postoperative agent. Sluder has stated that regardless of surgical measures—conservative or radical—the patient still has polyps. Polypoid degeneration of the nasal mucosa may be due to repeated attacks of coryza causing hyperemia of the tissues, exudation of serum into the interstitial spaces, and lymphoid and leucocytic infiltration into the submucosa.

In the early stages of the disease conservative removal of the polyps including a small area of surrounding tissue may suffice, while in the advanced stages radical procedures are necessary. Within four to seven days after a radical operation, or immediately after removal of local recurrences, radium may be applied to the ethmoid area. Gamma radiation with 50 mg. radium tubes for four to six hours is applied to each side of the nose. Great care must be taken to see that the radium tubes are properly and firmly placed to prevent dislodging to the nasopharynx, and also to prevent overaction on the nasal septum. The average case requires three or four applications at intervals of ten days to two weeks. In a series of more than 100 cases it has been found that in a high percentage of cases chronic nasal discharge, headaches and asthmatic attacks have been relieved, and that there is a longer freedom

* Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

from recurrences. The spongy myxomatous and vascular ethmoid areas become fibrous in character.

Fibromas of the nasopharynx form a definite clinical picture occurring in early adult life, more often in males than females. These tumors are usually pedunculated, arising from the vault of the nasopharynx or in the posterior ethmoid or sphenoid sinuses. The surgical treatment is attended with severe hemorrhages and frequent recurrences. Radium is used preoperatively to render the tumor smaller and less vascular. The insertion of tiny gold radon implants of 1.0 to 1.5 mc. strength has proved the best method of tteatment. A radiation necrosis of the tumor is to be avoided because of the danger of middle ear infection. Two or three months after the radon treatment it will be observed that many of the smaller tumors have disappeared, while the large masses are smaller and can be safely removed surgically.

In rhinoscleroma, a chronic inflammatory condition whose etiology is the Frisch bacillus, radium is effective in reducing the loose granulation fibrillar meshwork in the submucosa to dense fibrous tissue. In this way the nasal obstruction is relieved, and cures are obtained in the early cases, while in the advanced cases palliative relief may be expected for many months to a few years.

Atrophic rhinitis with offensive odor is rarely seen since greater attention is paid to the general health of children, including almost routine removal of tonsils and adenoids, and a prompt treatment of suppurative sinusitis. However, the condition does exist and treatments were unsatisfactory until the use of radium was instituted. The life history of ozena is that as a progressive fibrosis occurred over a period of years the odor became less. A little more than eight years ago, Dr. Louis Hubert, of the Manhattan Eye, Ear and Throat Hospital, suggested that the use of radium might produce a fibrosis earlier, and thereby hasten the course of the disease, abolish the foul odor and leave the structural atrophy. When we started this novel treatment we were unaware that it had been used by anyone else. In a careful search of the literature a few scattering reports in the European literature were found, which confirmed our conclusions that radium within a few weeks softened and reduced the amount of crusts, and that the odor disappeared in the majority of cases, and was greatly diminished in others. A foul odor caused by a chronic suppurating sinusitis in the antrum or sphenoid requires operation and not radium.

It is well known that lymphoid tissue is radiosensitive. In chronic lymphoid hyperplasia of the pharynx, as well as chronic tonsillitis, in which operation is contraindicated, radium acts by causing a shrinkage of the infected lymphoid areas. Surgical removal of tonsils, either under local or general anesthetic, by the skilled operator is so satisfactory and superior to other methods that the routine use of radium, roentgen rays or electrocoagulation should not be advocated.

In 75 per cent of the cases of tuberculous cervical adenitis complete excision of the lymph nodes is impractical. Early surgical removal of a localized tuberculous lymph node is a conservative procedure, but extensive dissection must be tempered with a consideration of the ultimate appearance of the neck, and safety to the surrounding structures. Radium as well as the roentgen ray produces an inflammatory reaction in the tissues, causing a shrinkage and gradual disappearance of the lymph nodes and a healing of the discharging sinuses. Cures are obtained in the majority of cases.

In vernal catarrh radium gives a great palliative effect. The granulations become much smaller, the discharge lessens, and the photophobia, pain and tearing are decidedly reduced. The technique employed is the application of a 5 mg. beta-ray plaque to the everted lids for five to eight minutes to each lid. The interval between treatments is from ten to fourteen days. In more than 50 per cent of the cases the patients become symptom-free. The tendency to recurrence in the early spring appears to be less in the treated cases. However, a few granulations will appear in nearly every case, and from one to three applications are needed to control the disease.*

* For discussion see page 804.

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THE TREATMENT OF CHRONIC INFECTION OF THE PAROTID GLAND*

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IN CHRONIC inflammation of the parotid gland with or without mild suppuration, the treatment generally advised frequently fails to relieve the condition. In many of these cases acute exacerbations occur with either a frank abscess or a cellulitis.

In this paper, we are only concerned with the treatment of the chronically inflamed gland with or without slight suppuration.

The usual treatment has consisted of prescribing mouth washes, instructing the patients to suck in an attempt to drain the gland through Stensen's duct, and passive massage to stimulate drainage from the gland. Ointments of various kinds have been used, hot or cold fomentations, and finally incision and drainage. None of these treatments have proved satisfactory. Most of the cases of chronic inflammation sooner or later have an acute exacerbation with abscess formation which requires surgical interference.

I have used radium in the treatment of acute postoperative parotitis for a number of years with gratifying results. The unsatisfactory results obtained by generally accepted treatment of chronic parotitis as contrasted with the results obtained in postoperative parotitis influenced us to try radium therapy in those cases.

In the 4 cases which we are reporting, there was a very gradual, more or less intermittent swelling of the parotid gland throughout the entire area. There was little if any pain. There was a slight rise of temperature at night in only 2 of the patients. In 3, a discharge from Stensen's duct was present. I know of no condition except infection which will give a purulent discharge from Stensen's duct.

CASE I, J. M., gave a history of a swelling which gradually increased in size in the region of the right parotid with a discharge of pus from Stensen's duct. He had no other physical signs and no leucocytosis. The condition almost entirely cleared up with massage. It recurred, however, a few weeks later and failed to respond to the usual treatment. We decided to apply radium over the swollen gland. The patient received two light radium treatments and within eight weeks the swelling had entirely disappeared and there was no evidence of pus discharging from Stensen's duct. The patient has now been well for five years.

CASE II, M. G., came to us with a history of two years' duration, during which time she had had massage, together with the usual treatments only to have two acute exacerbations requiring the lancing of abscesses. There was a history of swelling which gradually increased in size and discharge of pus from Stensen's duct.

On admission to the hospital, the patient had two discharging sinuses which had been present for eight months. This patient was given three light radium treatments and the swelling disappeared. The sinuses cleared up and there was no discharge of pus from Stensen's duct. About eight months later the patient returned with a swelling in the opposite gland and with a discharge of pus from Stensen's duct. This gland was treated with two light radium exposures and the swelling gradually cleared up. About six months later, there was a recurrence in the second gland. The patient received two more radium treatments and there has been no further recurrence during the past year.

CASE III, F. R., was one of a swelling of the parotid gland with a history of two years' duration. There was no redness or tenderness. There was, however, a sensation of fluctuation. No pus was obtained from Stensen's duct but the patient reported that at times she had a very foul tasting fluid which appeared in her mouth. In view of the fact that there were no constitutional symptoms, we decided to give three light radium treatments. The condition cleared up completely within eight weeks. The

* Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

patient has had no recurrence during the past two years.

CASE IV. S. G. In this case the swelling was more circumscribed and was about the size of a hen's egg. She gave a history of four weeks' duration. The consistency of this mass was similar to that of a mixed tumor of the parotid gland but mixed tumors are usually more slow-growing. There was no purulent discharge from Stensen's duct—there was no history of foul tasting material in the mouth. We treated this patient as a case of chronic parotitis, giving her three light radium treatments, and the mass disappeared. The patient has had no recurrence during the past two years.

Our experience with surgery in chronic parotitis has not been very satisfactory. It requires much time and suffering on the part of the patient and there is always the danger of dividing one or more branches of the seventh nerve. Surgical treatment makes it necessary to hospitalize the patient, with its additional economic burden, and there is always the danger of producing a parotid fistula which continues to drain long after the chronic inflammation has subsided. With massage the progress is very slow and the patient becomes discouraged and does not continue with the treatment. Results are very doubtful and recurrences often occur immediately after treatment is suspended. With the use of radium the patient is not hospitalized, there is no pain or discomfort, and no danger of fistula or injury to the seventh nerve. No dressing is required; no scar is produced and the patient is permitted to follow his usual routine. If recurrences occur, further radium treatment will invariably be effective.

The following technique has been used in the treatment of these cases with radium. The distance is 4 cm.; we use a filter of 4 mm. of lead, and 1,000 to 1,900 milligram-hours has been given per sitting. Usually not more than two treatments are necessary. The most we have given any patient has been 7,000 milligram-hours and this was given over a period of two years. Both glands were involved with recurrence.

It can readily be seen from this dosage of radium that there is practically no chance of producing any permanent destruction of the gland.

We would expect roentgen treatment with appropriate filtration and dose to produce the same results as radium.

It is our belief that when the question of differential diagnosis is involved, by the use of small doses of radium we can establish the diagnosis of chronic inflammation of the parotid. We think that with the swelling of the parotid gland and in the absence of a definite diagnosis, if small doses of radium are given and the swelling disappears, we are safe in thinking the lesion to be chronic inflammation. If large doses of radium are required, then we know we are not dealing with chronic inflammation. It is our experience that when large doses of radium are used in the presence of inflammation we obtain destruction of tissue out of proportion to the dose used.

DISCUSSION OF PAPERS BY DRS. ROBINSON AND DORRANCE

DR. ZOE A. JOHNSTON, Pittsburgh, Pa. Someone spoke of the amount of radium that can be safely used. I think, in these nonmalignant lesions it is more a question of how small an amount of radium one can use to produce the desired result. As I observe cases treated in the past I find, first, that I am gradually reducing the amount of radium used; second, that I am using more filtration; third, that I am spacing the treatments farther apart.

I enjoyed Dr. Robinson's presentation. In reviewing some of the benign lesions that we have treated, I find fibromas of the lingual and buccal mucous membrane occurring in children to be rather common. They seem to appear in crops and are very radiosensitive. One or two applications of heavily filtered radium causes them to disappear. Another benign condition is the tumor that arises from the superior maxilla and extends into the mouth. They are smooth, very hard and dense, and increase in size progressively. I have seen a number of these and bring the subject up for discussion because I would like to hear what Dr. Robinson and others have to say about this type of case. I have treated 4 or 5 of them. Two were treated

with radium filtered with 1 mm. of brass and 1 mm. of rubber. Those growths decreased and did not grow after the treatment. When I saw the next case I increased the dose and used a filtration of 2 mm. of brass and 2 mm. of rubber, and did not repeat the treatment until a year had elapsed. The growth was reduced in size and at the end of a year a second treatment was given in practically the same manner. This time there was a heavier reaction, a small sinus formed and a small piece of bone about one-half inch in length was expelled. The growth has reduced more than three-fourths of its original size. The fourth case treated after that was treated by the same technique but the second treatment has not yet been given. I have a case under observation that I am going to watch for a while before treating. I call them osteofibromas, or fibro-osteomas.

I am unable to discuss Dr. Dorrance's paper because I have not treated any cases of parotid gland involvement that have been of an acute inflammatory nature. All my cases have been of mixed tumor type.

Dr. Isaac Gerber, Boston. I wish to say a word or two concerning chronic infection of the parotid gland. I have been interested in this for some years and was greatly interested in the presentation of Dr. Dorrance.

I have had occasion to treat two types of parotid gland infection. One is the acute type that follows operations. If I remember rightly, in the past there has been a feeling that surgeons have always considered this more or less unsatisfactory. I have heard the remark that surgical intervention was apt to be fatal. In my experience small doses of roentgen therapy have taken care of these cases quite well. I have also seen 2 cases of the type Dr. Dorrance mentioned and in one of them a pure culture of *Staphylococcus aureus* was obtained from pus that came out through Stensen's duct. Two or three roentgen treatments, with filtration, were sufficient to reduce this infection.

I feel that this type of disease, like all other chronic infections, is far better and more easily treated with roentgen rays than with radium. It is true that these conditions may be treated with radium, but I do not feel that the mere accessibility of radium, or the fact that it is available in some locality or institution, should be relied upon as an indication for its use in chronic infections that are so easily treated by roentgen therapy. There is a saving in time and certainly an economic saving when you compare the cost of setting up the various types of radium applicators the essayist mentioned, contrasted with roentgen treatment that may last four or five minutes at most. Roentgen therapy is available over a far wider field, and is certainly much easier to use. I hope the surgeons will not feel that I am casting any aspersions at their willingness to treat chronic conditions by nonsurgical methods, but I think they should go a little further and allow these to be treated by agents that perhaps would not be available to them personally.

Dr. H. H. Bowing, Rochester, Minn. The treatment of acute infection of the parotid gland following operation is important. In discussing this problem some surgeons express the opinion that the inflammatory process is not a serious complication, whereas others say that it is very serious and that the mortality rate is very high.

I wish to say, in regard to acute parotid infection, that I prefer to treat such patients just as early as possible. If there is such a thing as an emergency case in radium therapy I think it is one of acute parotid infection. The surgical services are instructed immediately to report to us a case in which there is a tender spot or a small area of infiltration in the parotid region in order that radium surface packs may be applied. The earlier treatment is begun, the more prompt the result will be.

At the Clinic, heavily filtered radium surface packs are employed. The involved region is mapped into fields, 3×4 cm., and to each field a universal tube is applied. The tube contains 50 mg. of radium (element) filtered through the wall of the applicator, 0.5 mm. silver, 1 mm. brass, and 2 mm. lead, and is maintained at a distance of 2.5 cm. by the interposition of a balsa wood block. The treatment time to each field will vary from six to eight hours, and the number of fields may vary from four to twenty or more. The treatment is continuous until all fields have been covered. The size of the area is important; at first, treatment was limited to the parotid swelling, but now we are inclined to treat a larger area.

Following an interval of twenty-four to thirty-six hours, one may observe an acute exacerbation; this, however, usually subsides. As a rule, one treatment is sufficient; however, if necessary, a second course may be applied. I have encountered a few patients who needed surgical

attention later, although my impression is that such patients were treated later than forty-eight hours after the onset of the disease. The results usually are prompt and very satisfactory.

DR. JACOB R. FREID, New York City. I wonder how Dr. Dorrance handles the occasional patient with intermittent attacks of bilateral swelling of the parotid gland of obscure etiology. Although massage temporarily reduces the swelling, recurrences are frequent. In one such case, I have used radiotherapy without notable result.

DR. J. HERBERT BLISS, Brooklyn, N. Y. I with to emphasize Dr. Bowing's remarks regarding acute parotitis. Being interested in the surgical side as well as the radium side, we see parotitis develop occasionally and believe it to be very serious. During the past year we have used Dr. Bowing's technique and find it very satisfactory.

In our general surgical service at the Methodist Episcopal Hospital, Brooklyn, we have had 15 cases of acute parotitis following surgical operations during the past two years, with 2 deaths, both in cases in which radium was not used. In no case in which radium was used have we had a death. We believe it definitely shortens the period of infection and does not in any way interfere with surgical drainage of the parotid abscess should it develop.

DR. ARTHUR P. STOUT, New York City. I had an opportunity to see biopsies from 2 cases of chronic parotitis similar to what I think Dr. Dorrance is talking about, and in both of those there was a large quantity of lymphoid tissue. Perhaps that is the explanation of the success of small doses of radiation, and perhaps the reduction in the swelling produces better drainage and the infection in the glands subsides from mechanical reasons. It is difficult for me to understand how the irradiation could have an effect on the bacteria. I think it is well to remember that some of these cases might turn out to be Mikulicz's disease.

DR. W. E. HOWES, Brooklyn, N. Y. Referring to osteoma of the hard palate, I recall one case consisting of a large tumor plus ulceration of the mucous membrane. I suggested that it be resected surgically, which was done. This was followed by the application of a radium mold against the hard palate. The case has been followed for one year with an excellent end-result and no evidence of recurrence. I think we should leave the smaller growths alone.

DR. ROBINSON (closing). Radium, on account of its interstitial application, is helpful, and the fact that it may be localized at the inner canthus makes it convenient. In osteofibromas the surgical results are best.

Electrocoagulation of the tonsil was the fad last year, following the roentgen therapy of a few years ago. In the aged, chronic tonsillitis and pharyngitis are often present. In these cases one gold radon implant of 1.0 to 1.5 mc. strength may be inserted into the lower and upper poles of each tonsil, thereby causing a fibrosis with a disappearance of much lymphoid tissue. In lymphoid hyperplasia of the pharynx radiation, either radium or roentgen ray is helpful.

DR. DORRANCE (closing). I was one of the first to advise the use of radium in acute parotitis. The results here were so satisfactory that I used it later in the chronic cases. There are a few cases of Mikulicz's disease which are difficult to differentiate in their early stages. Radium is very valuable in chronic cases of parotitis with fistula. Someone said it is easier to use roentgen radiation. This is more than likely true. My cases were treated with radium.

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DEEP ROENTGEN THERAPY OF CARCINOMA OF THE BLADDER AND PROSTATE*

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CARCINOMA OF THE BLADDER

DURING the last four years only 8 cases of this disease have come through my hands; 7 cases in the hospital, and one case in private practice. All the hospital cases were very advanced—3 out of the 7 had had diathermy, and 2 of these 3 had had cystotomy. Four of these 7 cases died within thirteen months. Two are alive only six months after treatment, and of one I could obtain no record. The only other case that I have treated had extensive diathermy, with recurrent malignant papillomata. This patient is alive and well two years and nine months later. In this case, when treatment started, there was profuse bleeding, pain, and occasional obstruction due to blood clots. Still, from the middle of the course and since then, he has for some reason done extraordinarily well.

As I will stress later, it appears that deep roentgen therapy might be made more use of in these cases both before, and /or during any surgical or diathermic interference.

CARCINOMA OF THE PROSTRATE

Before passing on to prostatic carcinoma, it seems only right that hypertrophy of the prostate should be mentioned. All that is necessary to say is that in the last four years, including both hospital and private practice, only 8 cases of this type have been allowed to come to deep roentgen irradiation. All are well and relieved of symptoms. The literature on the subject of roentgen therapy of the malignant bladder and prostate is meager indeed compared with, say, that on cancer of the breast or buccal cavity. This rather signifies that successful results are even less common than in other regions commonly affected by carcinoma. The results in this paper are certainly depressing, but it must be remembered that in only 7 cases was the disease in an early stage, and these had all been subjected to operative interference.

Age Incidence	Cases
46 to 50 yr.	1
51 to 55 yr.	4
56 to 60 yr.	7
61 to 65 yr.	6
66 to 70 yr.	14
71 to 75 yr.	15
76 to 80 yr.	1
	48

This shows that 60.4 per cent occurred in the ten year period sixty-six to seventy-five.

Frequency. In every case frequency was a symptom. In every case that completed roentgen irradiation there was a lessening of the frequency, and for some period, at any rate, there was a considerable degree of relief from pain and discomfort.

Weight. In the cases that had at least one full course of roentgen therapy (34), all except 4 either gained or did not lose weight for at least four months afterwards. The 2 patients alive after three and a half years are both over a stone heavier in weight.

State of Involvement. The advanced nature of the disease when the patients are first sent for roentgen therapy can be gauged by the fact that out of 48 cases, 14 were unable to complete a course of treatment, and died within three months of being first seen (29 per cent). It must also be realized that in the greater number, not only was the prostatic condition far advanced, but the disease was also involving the bladder and even travelling downwards along the urethra. None of these had tissue removed for microscopic examination. This leaves 34 cases who were able

* Read at the Fifth Australian Cancer Conference, Canberra, April 17–20, 1934.

to undergo at least one course of roentgen therapy; but of these 34, seven only were considered by the surgeon to be operable. This means that out of 48 cases under review, 41 were in a very advanced, inoperable stage, i.e., 85.4 per cent.

Duration of Life. Going back again to the 34 cases treated: (*a*) 14 of these died from five to eighteen months after completion of therapy; (*b*) 2 are alive after three and a half years. In one of these, pathological examination showed adenocarcinoma. The other had no surgical interference. Both these patients are working at the present day. (When supplying statistics for this Conference ten months ago, neither of these was included in the "alive and well" column, as one had not then been heard of for some time, and the other was a private patient.) (*c*) There are 5 cases alive after eighteen months. (*d*) There are 6 cases alive after twelve months. The remainder have been treated since this time last year.

Of the 7 cases in this group who had prostatectomy performed, prior to deep roentgen therapy, 4 died within ten months of operation, 3 are alive eleven, sixteen, and forty-two months afterwards. In only one case was radium inserted, and this patient did not complete the roentgen therapy, dying three months later. In those patients who have died (20), metastases occurred in 13, or 65 per cent. The most common sites were in the deep abdominal glands, or in the bones of the pelvis. In 3 cases there was invasion of the pulmonary tissue. The cause of death in the remaining 18 cases was apparently due to bacillary infection of the whole urinary tract, with resultant toxic absorption cachexia, etc. No post-mortem examination was obtained in any case, as only one patient actually died in the hospital, and consent for further investigation was not given.

Technique. This has varied as the years have gone on. Ten years ago we used deep roentgen therapy in a very haphazard fashion. Four and a half years ago 190 kv. and 1 mm. Cu were practically standard. During the last nine months as much as 3 mm. Cu and 250 kv. have been common. Unfortunately, only far advanced cases have been sent for roentgen irradiation while this higher filtration and voltage have been in use.

The increase in roentgens delivered to the skin has risen from 1,200 r in the earlier days to 2,000 r when 3 mm. Cu and 250 kv. have been the filtration and voltage. The ports of entry include one perineal, two iliac and two gluteal. If it is apparent that the patient is obtaining some relief, and there is a possibility of his obtaining further benefit, then a further course of treatment is given about three months after the first. Coutard's divided dose technique is invariably used, and with 3 mm. Cu, 250 kv., there is no sign of damage to the skin when 2,000 r is given.

Roentgen Sickness. It seems advisable to make mention here regarding the injection of liver extract intramuscularly. Following an article published by Webster,[1] we have, not only in treating prostatic patients, but in other conditions as well, found that injection of 2 c.c. of liver extract given two or three times a week, is almost a panacea for post-irradiation sickness.

Urinary Antiseptics. All cases arriving for treatment have had a greater or lesser degree of bacilluria. The majority die from its effect. I feel that some organized treatment should be given. Several times patients have been returned to the urologist with a pathetic note requesting that some form of drug be used, by oral administration if possible, to try and relieve this dreadful flow of infected urine. Much misery and suffering could be prevented if this extreme pyuria could even to some extent be prevented. It is difficult to understand why so little apparent interest is taken in this side of treatment in prostatic carcinoma. Lately, as soon as a patient comes for deep roentgen therapy an attempt is made to prescribe for this distressing symptom.

[1] Webster, J. H. D. X-ray sickness treated successfully with liver extract. *Brit. M. J.*, 1934, *1*, 15–16.

The distressing results that the figures in this paper show demand that some effort should be made to improve results. The advanced stage of the disease at which patients have reported for treatment means that earlier diagnosis, on the one hand, and education of the public, on the other, must be attempted. I also suggest in cases where it is decided that surgery or diathermy is the best form of treatment, that preoperative deep roentgen irradiation should be given to the gland. Although the period of time is not sufficient to speak dogmatically, I feel that of late years more favorable results are being obtained in carcinoma of the breast when deep roentgen therapy is used before radical operation. So it seems advisable to irradiate before prostatectomy or canalization is attempted.

Secondly, the implantation of radon seeds, followed by roentgen irradiation, appears a possibility of improving our statistics.

The "under water" diathermy electrode is apparently giving good results in relieving distress and discomfort. However, this is not removing the main mass of malignant cells. Radical surgery in the stage at which the majority of patients present themselves seems out of the question. Therefore an attempt should be made to obtain better results by combined radium and roentgen irradiation.

There seems no doubt, even in these very advanced cases, that deep roentgen therapy does give great relief of pain, temporarily relieves frequency, and helps the mental condition considerably.

CONCLUSIONS

1. In 48 cases of carcinoma of the prostate, 14 were practically moribund when sent for treatment; and of the remaining 34, only 7 were in the operable stage.

2. No operable case was treated by irradiation alone.

3. It is urged that preoperative irradiation be given in all cases, and that in inoperable cases a series of cases be treated with radon seeds, and afterwards deep roentgen irradiation be given; these results to be carefully tabulated and brought forward at a later date.

4. Some attempt should be made as far as possible to keep the urine free from infection during treatment.

5. In advanced inoperable cases relief of pain and temporary relief from frequency follows deep roentgen therapy.

RESULTS OF RADIUM THERAPY IN BENIGN CONDITIONS OF THE UTERUS*

By JAMES A. CORSCADEN, M.D.
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DISCUSSION of the rôle of radium in the management of benign uterine conditions continues to be general. While there is considerable unanimity of opinion concerning the treatment of malignant neoplasms, there is a wide difference in the management of fibromyoma and idiopathic uterine bleeding. In one clinic a small minority will be operated upon while in another large gynecological teaching clinic there is no radium at all. This contribution is based on our experience with radium in the management of myoma of the uterus, uterine bleeding of benign nature and the discomforts associated with it. Myoma is accepted as a harmless tumor, peculiar in that it usually shrinks when menstruation ceases. Benign uterine bleeding is a vague term which may be clarified by the classification in Table 1 which arranges the causes of bleeding in three groups, each of which requires a therapeutic approach quite different from the others. Functional bleeding is best controlled by a restoration to normal of that function and, failing that, a termination of it. Various diseases require treatment according to the nature of the disease but directed toward the disease rather than the bleeding. Bleeding from a pregnant uterus demands action in certain conditions to preserve the ovum and to complete its removal in others. Bleeding associated with all of the conditions listed in Table 1 is "benign" except that occurring in carcinoma, sarcoma and chorionepithelioma, and the precise mechanism behind it should be understood before any form of therapy is recommended. With bleeding from a myomatous uterus, for instance, it is important to determine, if possible, whether the bleeding is of a functional (ovarian, pituitary) nature, or whether it comes from a congested uterus or from an ulcerated surface. Congestion of the uterus alone rarely causes excessive bleeding so that where this is a factor, the termination of the sexual cycle will usually terminate the bleeding as readily as in those cases where the disturbance is purely functional, whereas bleeding from an ulcerated surface is likely to continue even after menstruation has ceased, as in the following cases:

TABLE 1

UTERINE BLEEDING

- Functional
  - Normal uterus
  - Cystic and glandular hyperplasia
  - Fibrosis uteri
  - Coincident (myoma, ovarian cysts etc.)
- Organic Disease
  - Trauma
  - Ulceration
    - Traumatic
    - Trophic
    - Infections
    - Neoplasms
      - Benign
        - Polyps
        - Submucous myoma
        - Adenomyoma
      - Malignant
        - Carcinoma
        - Sarcoma
        - Chlorionepithelioma
  - Congestion. Inflammation, myoma, displacements, etc.
  - Diseases of blood and blood vessels
- Pregnancy. Ectopic, abortions, accidental, placenta previa

A woman, aged forty-five, with a uterus the size of a five months' pregnancy, was treated with radium for severe menorrhagia and metrorrhagia. At the curettage nothing was discovered except distortion of the uterine cavity. Irregular bleeding persisted after the radium treatment and again, despite the presence of hot flashes, after the administration of a sterilizing dose of roentgen radiation. Curettage was refused. Four years after the radium treatment, there was a sharp attack of bleeding. The patient passed an endometrial polyp 2×2×4 cm., attached by a pedicle 0.5 cm. in diameter. At curettage the uterus was slightly enlarged, the cavity symmetrical, the endometrium atrophic. Since that time (sixteen

* Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

Fig. 1. Photograph of a uterus removed three weeks after the intrauterine application of 50 mg. of radium for twenty-four hours filtered by 0.5 mm. silver and 1 mm. rubber, showing destruction of the endometrium over an area approximately one-fourth the area of the total endometrium.

Fig. 2. Microscopic picture of the base of the ulcer shown in Figure 1.

months), there has been no bleeding of any kind.

Another patient came to us with bleeding persisting after four curettages and three intrauterine applications of radium. There was a pedunculated myoma of the uterus, shaped like a castanet, which divided the uterine cavity into an anterior and posterior symmetrical space into which a sound or curette would pass with ease. Bleeding ceased after the removal of the tumor.

Diseases of the blood and blood vessels may cause bleeding from the uterus as from other surfaces. One case of purpura was treated unsuccessfully by radium. Bleeding from lacerated cervices, from senile vaginitis and from inflammatory diseases of the cervix has not been treated here with radium. "Benign bleeding," then, signifies bleeding due to disturbances of the sexual cycle and bleeding due to unknown factors (idiopathic) in which, however, menstruation plays a part.

The physiological effects of radium must be kept in mind when attacking bleeding of this kind. Figures 1 and 2 show the local cauterizing effect limited to an area about 2 cm. in diameter. Figure 3 shows the condition of the remainder of the endometrium. Obviously the termination of bleeding from such a uterus will not depend on this limited local caustic effect. Figure 4 shows the effect on the submucous blood vessels.

Fig. 3. Section of the endometrium taken from the area apparently unaffected by radium, showing continued hyperplasia and no evidence of destruction by radium.

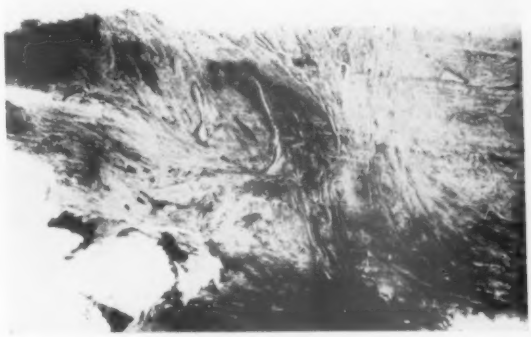

Fig. 4. The blood vessels of the myometrium show considerable thrombosis.

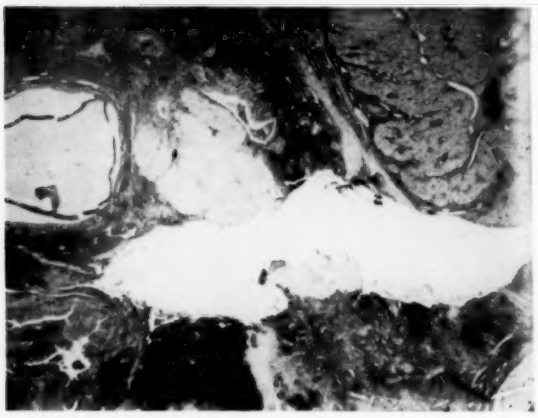

FIG. 5. Section of a grossly normal ovary taken from a woman twenty-six years of age, showing ripe follicles, corpus luteum and corpus albicans.

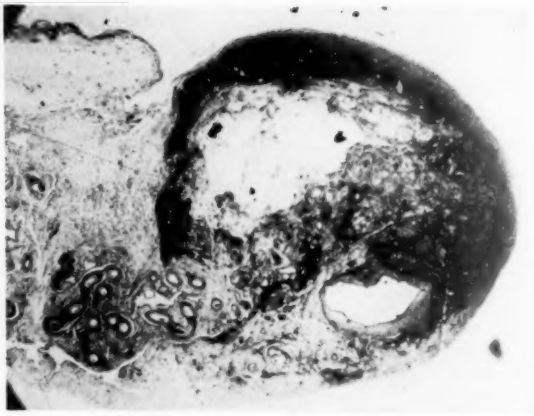

FIG. 6. Section of an ovary from a woman five years past the menopause, showing stroma and corpora albicantia.

Figure 5 shows a normal ovary from a woman aged twenty-six; Figure 6 a senile ovary, and Figure 7 the ovary of a girl aged twenty-six treated for five years by roentgen irradiation for Hodgkin's disease. Note in this absence of practically all follicular elements as contrasted with the numerous corpora albicantia in the senile ovary and the varied follicles in the normal ovary. By a comparison of dosage and the local and general effects of radium, we conclude that while there may be a temporary effect on bleeding from local caustic action and from changes in the blood vessels immediately beneath the radium, permanent effects must depend on the destruction of the ripe follicles of the ovary.

FIG. 7. Section of an ovary removed at autopsy from a woman twenty-six years of age treated for seven years by roentgen irradiation for Hodgkin's disease. Amenorrhea had been present for five years. The corpus albicans shown is the only one present in that section taken through the whole ovary.

To treat most efficiently a woman bleeding from the uterus or having a pelvic mass apparently arising in the uterus, many factors must be simultaneously considered. To attend to certain problems and ignore the remainder may cause unnecessary operations, on the one hand, or may, on the other, cause important diseases to be neglected or bring about menopausal distress in an individual ill suited to bear it.

Table II is a summary of the treatment of these conditions. On one line are indicated the various treatments available and on the other the conditions and circumstances to be considered when choosing any method of treatment. We shall here ignore all of these methods except radium, and attempt to present the results in our experience in such a way as to answer the questions brought up by the headings on the left hand column.

1. Most important is bleeding. In studying the results of radiotherapy on bleeding it is convenient to divide the patients into three age groups: (1) the years following puberty, (2) the active child-bearing period and (3) the age after which a termination of menstruation is not considered abnormal, and again into groups arranged

TABLE II

SUMMARY OF METHODS AND INDICATIONS IN THE MANAGEMENT OF MYOMA OF THE UTERUS

	Observation and General Treatment	Curettage	Myomectomy	Supravaginal Hysterectomy without Ovarectomy	Complete Hysterectomy without Ovarectomy	Hysterectomy with Ovarectomy	Ovarectomy	Radium, Sterilizing Dose	Radium, Partial Dose	X-ray, Sterilizing Dose	X-ray, Partial Dose
Symptoms											
Bleeding	1	1	2	4	4	4	3	3	2	3	2
Dysmenorrhea	1	2	?	4	4	4	4	4	3	4	3
Molimen	1	2	?	4	4	4	4	4	3	4	3
Other pain	0	0	1	3	3	3	2	2	2	2	2
Urinary symptoms	0	0	1	3	3	3	2	2	1	2	1
Pathology											
Effect on											
Size of mass	0	0	3	4	4	4	2	3	1	3	1
Extrauterine lesions	0	2	4	4	4	4	4	2	2	0	0
Subsequent Uterine											
Degeneration	0	0	3	4	4	4	3	3	3	3	3
Sarcoma	0	0	3	4	4	4	3	3	3	3	3
Carcinoma	0	1	0	2	4	?	?	?	?	?	?
Subsequent Adnexal											
Neoplasms	0	0	0	0	0	4	4	0	0	0	0
Effect of Operation											
Immediate											
Death	0	−1	−3	−3	−4	−4	−2	−1	−1	−1	−1
Postoperative distress	0	−1	−4	−4	−4	−4	−4	−1	−1	−1	−1
Economic loss	0	−1	−4	−4	−4	−4	−4	−1	−1	−1	−1
Menopause											
Hot flashes	0	0	0	−2	−2	−4	−4	−4	−4	−4	−4
Nervous symptoms	0	0	−1	−1	−1	−1	−1	−1	−1	−1	−1
Sex characteristics	0	0	0	0	0	0	0	0	0	0	0
Libido	0	0	0	0	0	−1	−1	0	0	0	0
Present Pregnancy	0	−4	−2	−4	−4	−4	−4	−4	−4	−4	−4
Future Pregnancy	0	1	1	−4	−4	−4	−4	−4	−4	−4	−4

Numerals indicate degrees of good or bad effects.
4—Best possible result.
−4—Worst possible effect.
0—No effect one way or the other.

according to the size of the uterus, and in each of these groups to study the effects of the different dosages (Table III). Depending largely on the age of the patient, a dose of radium up to 600 mg-hr. may produce any effect from nothing at all up to a permanent menopause. In young women the periods are almost certain to continue or to reappear after an interval of several months, but in women over forty and in certain women in their thirties, permanent amenorrhea is quite possible. With improving endocrinologic therapy, indication for small doses in young women will become

TABLE III—UTERINE BLEEDING

Uteri in size up to that of a 2½ months' pregnancy

AGE UP TO 25

Dose mg-hr.	Stopped after (mo.) 0	1	2	3	Continued Normal	Excess	Controlled No Rx	X-ray	Ra	Hysterectomy	Recurred after (yr.) ½	1	3	5	Controlled No Rx	X-ray	Ra	Hysterectomy	Satisfactory	Unsatisfactory
600	3	1			1	2	1		1	1		2	2		3		1		6	1
1,200																				
1,800																				
2,400																				
Total	3	1			1	2	1		1	1		2	2		3		1		6	1

AGES 25–38

600		1				2		1		1									2	1
1,200	4	3	1		1	1	1			1		4	1		3	1	1		9	1
1,800	14	8	1									2	1		3				23	0
2,400	2					1				1									2	1
Total	20	12	2		1	4	1	1		3		6	2		6	1	1		36	3

AGES OVER 38

600	2	1	2	1		1		1				1					1		7	0
1,200	45	30	7	2	1	1		1	1		1	6	2		6	3			86	0
1,800	72	36	13	5							2	8	2	2	14				126	0
2,400	20	4		1							1	1	1		3				25	0
Total	139	71	22	9	1	2		2	1		4	16	5	2	23	3	1		244	0
TOTAL	162	84	24	9	3	8	2	3	1	4	6	24	7	2	32	4	3		286	4

Uteri in size from 2½ to 5 months' pregnancy

AGES 25–38

600					1														1	0
1,200	1	2		1	1	1				1		1		1	1			1	4	2
1,800	2											1			1				2	0
2,400	1																		1	0
Total	4	2		1	2	1				1		2		1	2		1		8	2

AGES OVER 38

600		1																	1	0
1,200	15	7	3	3	2			2			3	2	1		5	1			30	0
1,800	13	14	2	1		1				1		3			1	2			30	1
2,400	6	1	2	1	1			1											11	0
Total	34	23	7	5	3	1		3		1	3	5	1		6	3			72	1
TOTAL	38	25	7	6	5	2		3		2	3	7	1	1	8	3		1	80	3

UTERI LARGER THAN THAT OF A 6 MONTHS' PREGNANCY IN WOMEN OVER 38 YEARS OF AGE

1,200	3	1	1			1				1									5	1
1,800			1	1									1				1		1	1
2,400	1	1			3			2		1						1			4	1
Total	4	2	2	1	3	1		2		2			1			1	1		10	3
GRAND TOTAL	204	111	33	16	11	11	2	8	1	8	9	31	9	3	40	8	3	2	376	10

much less frequent. This is to be desired since radiotherapy is destructive and therefore illogical. It is reserved for young women in whom the only alternative is hysterectomy. In order to protect the endometrium, roentgen irradiation is preferred. If local caustic action is desired an ordinary caustic such as iodine or acetone is preferable to radium. Where a myoma is present, a myomectomy is attempted and if this is impractical, hysterectomy, which, in a young woman, in my experience, is followed by less discomfort in the long run than is the artificial menopause. Where a permanent cessation of bleeding is decided upon, a certain result requires a much larger dose. Twelve hundred milligram-hours of radium in a small uterus will, with reasonable certainty (91.6 per cent), stop the bleeding within three months and followed by supplementary roentgen irradiation, if necessary, promise a completely satisfactory result in 98.9 per cent of the cases. A dose of 1,800 mg-hr. promises a much earlier cessation of the bleeding and will require supplementary treatment less often. Although 14 out of 126 patients had some scant bleeding from six months to ten years after operation, none required subsequent treatment. With a dosage of 2,400 mg-hr., the results are still more prompt.

Where the uterus is of medium size, the results are good but more varied. Secondary treatments for all dosages are more frequently needed and hysterectomy for persistence and recurrence of bleeding becomes more frequent.

With a uterus larger than a six months' pregnancy, the results are still less reliable. For this reason and because of the greater possibility of an error in diagnosis, hysterectomy has come to be the method of choice. If there is any contraindication, a curettage is performed, 1,800 to 2,400 mg-hr. of radium inserted, and while the patient is still in the hospital, she is given a full sterilizing dose of roentgen radiation. It is felt that the enlarged uterus so displaces the ovary as to push it out of range of the radium.

It is interesting to note that no matter how large the radium dose, menstrual periods may continue as long as three months. In this connection, it is interesting to note that one woman of thirty-six, treated with 7,000 mg-hr. of radium for epithelioma of the cervix, had a normal period three weeks after operation.

Where a myomatous uterus is larger than that of a four months' pregnancy, roentgen irradiation supplementary to any radium dose is necessary for a certain termination of the bleeding. The only advantage of smaller dosage is the alleged lessening of the "menopause symptoms." In my experience the only constant menopause symptom (the hot flash) is to be expected when amenorrhea is present, irrespective of the dose. Further, it has seemed that the hot flashes have been less severe in women treated by huge doses for epithelioma of the cervix. It is inferred that the hot flash depends on the absence of certain endocrine substances from the blood, whether this acts by depriving the vasomotor mechanism of substances necessary for stability or whether the absence of estrin stimulates an outpouring of an excess of (possibly) pituitary substances which in turn correct the instability of the vasomotor system. It is also more definitely apparent that a permanent amenorrhea depends on the continued absence of ovarian products (estrin) from the circulation. Any middle ground has not been apparent in these cases.

Dysmenorrhea has ceased with the onset of amenorrhea. Rarely there have been uterine cramps recurring at regular intervals for one or two months after bleeding has ceased. Pelvic or abdominal pain unassociated with menstruation has been relieved in 50 per cent of the cases and urinary distress in 40 per cent. Of the many complaints associated with menstruation, headache was taken as an example.[2] The effect of the artificial menopause on this symptom is shown in Table IV, which indicates that relief from headache by the artificial menopause depends upon its

TABLE IV

EFFECT OF THE RADIOTHERAPEUTIC MENOPAUSE ON HEADACHE

	Satisfactory			Unsatisfactory		Total
	Immediate Relief	Delayed Relief	Partial Relief	Slight Relief	No Relief	
Periodic, with menstruation	58	13	14	0	1	86
Irregular with exacerbation at menstruation	0	4	2	0	2	8
Irregular	0	2	5	4	11	22
TOTAL	58	19	21	4	14	116

coincidence with the menstrual periods.

11. When the problem of the local lesion is reached, several questions arise. (1) Will myomatous uteri shrink satisfactorily after the application of radium? (2) Will complications dependent upon the radium application be of importance? (3) Will important pelvic lesions be overlooked in our preoperative examinations with such frequency as to make dangerous the foregoing of the exploratory laparotomy incident to hysterectomy? (4) Will important conditions develop in these uteri if left in situ? (5) Will important extrauterine disease occur with sufficient frequency in later years to make routine removal of the pelvic organs desirable?

(1) The amount of reduction following radium and roentgen therapy is indicated in Table v. It was necessary to include both forms of treatment because a considerable proportion of the patients, in view of the importance of the law of inverse squares in these large masses, have received roentgen therapy. As with bleeding, the results in masses in size up to that of a six months' pregnancy are excellent but in the larger, fall short of the ideal. For this added reason, hysterectomy seems to be the method of choice for large tumors.

(2) Of complications following treatment by radium[1] there have been 4 cases of uterine inflammation probably to be attributed to operative contamination rather than to the lighting up of an old focus of infection. Doubtful signs of degeneration in a myoma the size of a five months' pregnancy occurred in one patient who suffered little disability therefrom, and in whom there was complete reduction of the tumor.

(3) Diagnostic errors were revealed in 2 cases; in one a sarcoma and in the other an endometrial polyp. This favorable record is due to the fact that all of these patients have received a careful gynecological preoperative investigation. When the diagnosis was doubtful preoperatively or at the diagnostic curettage, laparotomy was performed. These patients therefore are a carefully selected group.

TABLE V

REDUCTION IN SIZE OF TUMOR

Original Size	Satisfactory Reduction				Unsatisfactory Reduction			Total Cases
	50%	75%	Complete	Totals	None	Slight	Totals	
3–4 mo.	4	19	71	94 (94.9%)	3	2	5 (5.1%)	99
5–6 mo.	2	9	6	14 (93.3%)	0	1	1 (6.7%)	15
7–8 mo.	0	1	1	2 (50.0%)	0	2	2 (50.0%)	4
Total	6 (5.1%)	26 (22.1%)	78 (66.1%)	110 (93.2%)	3 (2.5%)	5 (4.2%)	8 (6.8%)	118

The question of the possibility of important errors in diagnosis is more important than all others from the standpoint of one who conducts a critical follow-up clinic. It was approached therefore from another standpoint. The pathological findings of 1,000 cases of hysterectomy for uterine myoma were studied for the purpose of estimating diagnostic efficiency and particularly to determine the amount of potential harm to the patient had these lesions not been discovered and removed.

In the 1,000 patients in addition to the 1,000 myomata, 832 complicating conditions were found which had been missed in the preoperative study. These will be more elaborately analyzed in a later communication. It suffices here to say that 544 lesions were of no importance, such as tiny follicular cysts of the ovary, microscopic evidence of chronic salpingitis, etc.; 119 were of minor importance (small cystic ovaries, gross but symptomless chronic salpingitis, slight peritoneal adhesions etc.); 149 were of a type which would probably prejudice the health of the patient or even threaten life; 16 of these should have been discovered at the diagnostic curettage; 95 were recognized in the operating room; 51 were only discovered in the pathological laboratory and 3 (all extrapelvic) during convalescence. Roughly, 10 per cent of the cases had lesions of major importance which were not diagnosed before operation. The discrepancy between the apparent diagnostic indices of the radiotherapeutic and operative cases has many explanations, but most important is the meticulous care in excluding doubtful cases from radiotherapy and, on the other hand, a certain degree of laxity in the presence of an obvious large uterine mass. Feeling that an exploratory laparotomy is inevitable, the surgeon is tempted to rely on this means to settle questions of diagnosis. While this is proper with extrauterine conditions, it is of serious import in the presence of carcinoma of cervix or corpus. These must be as intensively sought in the large myomatous uterus as in one of normal dimensions.

(4) Among 556 patients followed for an average of seven years following operation, there has occurred one adenosarcoma of the endometrium twelve years after operation for bleeding from a grossly normal uterus; one adenocarcinoma of the uterus eight years after operation for bleeding from a myomatous uterus; one epithelioma of the cervix six years after operation for bleeding from a normal uterus and one epithelioma of the cervix seven years after operation for bleeding from a myomatous uterus.

(5) There has been one carcinoma of the ovary occurring ten years after operation for bleeding from a normal uterus; one cystadenoma of the ovary five years after operation for bleeding from a normal uterus; one cystadenoma four years after operation for bleeding in a myomatous uterus and one simple cyst seven years after operation for bleeding from a myomatous uterus.

The occurrence of these conditions and the possibility of immediate diagnostic error raise the question as to whether all cases of bleeding or myoma of the uterus should not be operated upon. This would include at least half the adult female population and would at present be a fantastic proposal, but with advances in knowledge concerning the nature of shock and the application of methods which tend toward its elimination, it is not unthinkable. Until such an utopia is reached, radium and roentgen therapy will have a broad field of usage always with ever increasing emphasis on precision in preoperative diagnosis.

III. The ill effects of radium treatment divide themselves into those caused by the operative procedure and the immediate destructive action of the radium and, secondly, upon the menopause resulting from the destruction of the graafian follicles. Of these the latter is of greater importance. While there may be operative[1] accidents and a certain amount of distress and disability, following curettage and insertion of radium, these are trivial compared with any other procedure which would effectively stop the

bleeding or eliminate the tumor. The menopause, on the other hand, should be a matter for concentrated study not only in the abstract but as it concerns each individual. The subject is so large, however, that it should be a subject for an individual thesis. Here we will only mention that errors in interpretation in the cases studied have been mostly on the side of overemphasis on the importance of the menopause, but it also should be noted that in a few cases an artificial menopause has been produced in women who should have had their menstrual cycle preserved.

CONCLUSIONS

1. Bleeding from the uterus, with or without a myoma, in the absence of ulceration will cease after radiotherapy in adequate dosage.

2. Small doses of radium in young women produce uncertain results and in older women may cause a permanent menopause.

3. In the presence of large myomata roentgen treatment should follow the application of radium.

4. The size of the myomatous uterus has been satisfactorily reduced in 92 per cent of the cases. Masses larger than a six months' pregnancy show very poor results when compared with those of smaller size.

5. Accuracy in diagnosis is the most important phase of radiotherapy The diagnostic curettage should be employed in nearly all cases and exploratory laparotomy when there is any doubt concerning the condition of the adnexa.

6. Except for manifestations incident to the menopause, the occurrence of important unfavorable sequelae has been rare.*

* For discussion see page 822.

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BENIGN UTERINE HEMORRHAGE

WITH SPECIAL CONSIDERATION OF RADIATION THERAPY*

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RADIATION therapy for uterine hemorrhages caused by benign lesions has definite indications. Hemorrhages should not be treated without a corroboration of the clinical diagnosis by diagnostic curettage or biopsy and microscopic examination of all tissue removed.

The Frequency of Uterine Hemorrhages. In 1928 the frequency of uterine hemorrhages in 2,184 consecutive gynecological patients was found to be 707, or 35.29 per cent. The malignant diseases furnished 184 cases, or 23.89 per cent, and the benign lesions 586, or 76.11 per cent. The latter were caused: (1) by extragenital diseases; (2) by accidents of pregnancy, labor and puerperium; (3) by physiological or anatomical pathologic changes in the genital organs.

The Types of Uterine Hemorrhages. The benign hemorrhages were grouped according to the type of bleeding: (1) Hypermenorrheas: the menstrual flow was too profuse or lasted too long. They numbered 350 of the 586 cases, or 59.72 per cent; (2) polymenorrheas: the menstrual flow occurred too soon. They amounted to 111 of the 586 cases, or 18.93 per cent; (3) metrorrhagias: the uterine hemorrhages occurred independently of the menstrual flow. They accounted for 125 of the 586 cases, or 21.35 per cent.

The Causes of Uterine Hemorrhages. The causes of hypermenorrhea are: (1) loss of coagulation power of the blood due to an absence of luteinization in the cells of the stratum granulosum resulting from a deficiency in the formation of prolan B, the luteinizing hormone; (2) loss of contractility of the uterine muscle due to hypoplasia, asthenia or atony of the myometrium, and myomas preventing contraction of the muscle; (3) active and passive hyperemia caused by pelvic infections and displacements and general constitutional disturbances such as organic, cardiac, pulmonic, hepatic and nephritic diseases and some acute infectious diseases.

Polymenorrhea may ensue: (1) from disturbances in the process of ovulation the result of endocrine imbalance causing either a shortening of the time of follicle ripening or a shortening of the corpus luteum stage. They are termed primary ovarian dysfunction; (2) from inflammatory diseases of the ovaries; (3) from active and passive hyperemia of the ovaries due to genital or somatic disturbances. The last two causes are termed secondary ovarian dysfunction.

Metrorrhagia is always accompanied by a loss of continuity of the surface epithelium resulting (1) from persistent follicle and consequent endometrial hyperplasia; (2) acute genital infections as gonorrhea and sepsis; (3) disturbances of pregnancy, labor and puerperium; (4) granulosa cell tumors of the ovary; (5) malignant diseases of the cervix and body of the uterus.

The Treatment of Uterine Hemorrhages. It may be stated that the hemorrhages due to primary uterine and primary ovarian dysfunctions are to be considered in the discussion. The hemorrhages resulting from an anatomical pathology obviously require medical or surgical treatment. The removal of the diseased tissues or the natural processes of resorption should bring about normal menstrual behavior. The only exceptions are formed by bleeding uterine myomas and endometriomas which may become symptomless and often disappear entirely after temporary or permanent cessation of ovulation by means of irradiation.

The treatment of benign primary uterine

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and ovarian hemorrhage is medical, surgical or radiological. The number of hypermenorrheas in which radiation treatment was indicated was 20 of 73 cases of primary functional uterine bleeding, or 27.39 per cent. The number of polymenorrheas treated with radiation was 3 of 30 primary ovarian dysfunctions, or 10 per cent. The number of metrorrhagias treated with radiation was 22 of 36 cases of persistent follicle or hemorrhagic metropathy, or 61.10 per cent. Hence in a total of 149 functional uterine and ovarian hemorrhages 45 cases, or 32.31 per cent, were subjected to radiation therapy.

There were 145 uterine myomas in the series of 2,184 gynecological cases, an incidence of 6.64 per cent. The bleeding myomas already enumerated under the frequency and causes of uterine hemorrhages were 90, or 62.07 per cent. Of the bleeding myomas 16, or 17.78 per cent, were irradiated.

Additional Data. This study has been continued to comprise a total of 436 cases of functional hemorrhages and myomas that had definite indications for radiation therapy. This group does not include the hemorrhages arrested by medical and surgical measures. The cases were divided as shown in Table 1. The use of surgery or radiation should depend on the age of the patient. Restitution of normal genital functions must always be the object in the child-bearing period.

TABLE I

CAUSES OF BENIGN UTERINE HEMORRHAGES

Diagnosis	Number	Per cent
Functional hemorrhages		
a. Juvenile: up to 20 years	10	
b. Matural: from 21–35 years	69	
c. Menopausal: from 36–50 years	174	58.50
d. Senile: 51 years or older	25	5.12
Undeterminable causes	36	8.39
	314	72.01
Myomas		
a. Up to 35 years	21	
b. 36 years or older	97	
c. Endometriomas	4	
	122	27.99

Functional Hemorrhages of the Uterus. Indications and Results of Radiation Treatment. The indications for irradiation in the functional hemorrhages of the uterus are:

A bleeding uterus that has resisted conservative measures of treatment and is not associated with pelvic infections.

In women of the juvenile period up to twenty years, and mature period of life from twenty-one to thirty-five years of age, temporary amenorrhea should be produced. Roentgen rays are preferable as the dose can be more correctly determined than with radium. Women in the menopausal period from thirty-six to fifty years of age and the senile period, fifty-one years or older, may be treated with either roentgen rays or radium. As radiation treatment must be preceded by a curettage to rule out a possible malignancy, radium is used by choice. However, radium treatment is almost invariably followed by an annoying and profuse watery secretion which may last for six or more months and by a hydrometra if the internal os has been scarred by the caustic action of the gamma rays. Roentgen rays act directly on the ovaries and the watery discharge is not seen.

The roentgen dose for the production of permanent amenorrhea is about 400 r with back-scattering measured in the mid-pelvis and attained through two fields, one suprapubic and one sacral. The roentgen dose for the production of temporary amenorrhea is 25 per cent less than the castration dose or 300 r with back-scattering attained in the mid-pelvis through an anterior and a posterior field. The kilovoltage should be 200 and the filter 0.5 to 0.75 mm. copper plus 1.0 mm. aluminum. The output of transformer and Coolidge tube must be standardized with r meters to attain the expected result. The recurrence of the menses is usually preceded by menstrual molimen during the last two or three months of the amenorrheal period.

The doses of gamma rays necessary to

control uterine bleeding are well known and therefore will not be repeated.

The results of radiation therapy in 322 cases of functional uterine bleeding were as follows:

Radiation	Number	Repetition of Treatment	Good results of Treatment	
			Number	Per cent
Radium	290	9	286	98.62
Roentgen rays	24	2	22	91.64
Total	314		308	98.09

The complications following radium therapy were: 3 hysterectomies for recurrent bleeding, 1 death from sepsis; following roentgen therapy: 1 hysterectomy and 1 death from carcinoma of the corpus uteri six months later. Hence the mortality was 2, or 0.66 per cent. In only 1 patient was a malignancy overlooked. Nine cases in this group were clinically diagnosed as carcinomas. The diagnosis could not be corroborated microscopically. Such cases are always treated as malignant either by using 3,000 mg-el-hr. of gamma rays or corresponding doses of roentgen rays.

Uterine Myomas. Indications and Results of Radiation Treatment. The treatment of bleeding uterine myomas is either surgical or radiological. The statement may be made that patients not older than thirty-five years or patients older than thirty-five years desiring offspring should be treated surgically but conservatively, that, is myomectomy should be done to preserve the functions of the uterus.

Irradiation is indicated in: (1) A bleeding myoma free from adnexal complications, degenerations or malignancy and located intramurally in a patient thirty-six years or older; (2) women younger than thirty-six years who are poor surgical risks due to constitutional complications; (3) radium may be used in uteri not larger than a first trimester pregnancy and roentgen irradiation in myomas of all sizes.

The number of uterine myomas referred for radiation therapy was 122. Re-examinations revealed 13 cases with indications for surgery, namely: pedunculated myomas, 2; one proved to be a leiomyosarcoma; myoma and carcinoma of rectum, 1 case. After exploratory laparotomy radiation therapy was instituted. The patient succumbed four months later from an intestinal obstruction. Multilocular myomas, 9 cases. Such multiple myomas are always associated with subserous and submucous myomata and radiation treatment is contraindicated.

The results of radiation therapy in 109 myomas were as follows:

Radiation	Number	Repetition of Treatment	Good End-Results of Treatment	
			Number	Per cent
Radium	85	8	80	94.12
Roentgen rays	24	1	23	95.9
Total	109		103	94.5

The complications and failures after radium treatment were: hysterectomy for uncontrollable recurrent bleeding had to be performed in 3 cases, three, nine and twelve months after irradiation; sarcoma in 1 case, three years after irradiation, resulting in death; 1 mortality from sepsis; 1 morbidity due to pelvic abscess cured by posterior colpotomy. After roentgen treatment 1 patient had a hysterectomy six months later for persistent bleeding.

Therefore 1 death was due to irradiation, which gives a mortality rate of 0.86 per cent. If the 1 malignancy occurring three years later is included then the mortality rate is 1.72 per cent.

CONCLUSIONS

The necessity of careful selection of so-called benign uterine hemorrhages has been deduced from a careful clinical study. Such hemorrhages should never be treated without a diagnostic curettage or biopsy of uterine tissue. Radiation therapy should be confined to primary functional uterine

hemorrhages and bleeding myomata. The percentages of functional uterine hemorrhages indicating radiation therapy were 32.31 and of bleeding uterine myomas 17.78.

The good end-results of radiation treatment in the functional uterine hemorrhages was 316 in a total of 322 cases, or 98.14 per cent, and the mortality was 0.66 per cent.

The good end-results of radiation treatment in bleeding uterine myomas was 103 in a total of 109 cases, or 94.5 per cent. The mortality was one, or 0.86 per cent; if the mortality of the sarcoma occurring three years later is included the rate is 1.72 per cent

In the entire group of 436 benign uterine hemorrhages only one malignancy of the uterine body was overlooked, while a sarcoma appeared three years later in another patient.

The good end-results and the safe exclusion of possible malignancies by careful examination and diagnostic curettage in all but one of the cases justifies the statement that radiation therapy has earned an important place in the treatment of benign uterine hemorrhages.

DISCUSSION ON PAPERS OF DR. CORSCADEN AND DR. SCHMITZ

DR. CHARLES C. NORRIS, Philadelphia. The papers of Dr. Corscaden and Dr. Schmitz constitute two important contributions to radiation therapy. Both Dr. Corscaden and Dr. Schmitz are to be congratulated upon the excellence of their results. The place of irradiation in the treatment of benign hemorrhage is now well established. This form of treatment is satisfactory in a large proportion of cases and possesses the additional advantage of not seriously militating against subsequent operations in the extremely small proportion of cases in which it is not successful. Its efficiency, safety, and the short convalescence following this method of treatment, together with its economic advantages, constitute distinct advantages over operation. That the treatment may be abused and employed in improper cases is its chief drawback. I am glad to find that both Dr. Corscaden and Dr. Schmitz emphasize the importance of accuracy in diagnosis. In the John Goodrich Clark Clinic at the Hospital of the University of Pennsylvania, and in teaching our students, this point is emphatically stressed. For whereas the diagnosis in these cases is usually easy for the man experienced in pelvic surgery, in any large series of cases an occasional one is encountered in which doubt upon this point may exist. In really doubtful cases I believe operation is generally preferable to irradiation. Irradiation, like surgery, is a dangerous weapon in the hands of the inexperienced. When indicated, biopsy should be employed and routine diagnostic curettage should be performed. Twenty per cent of our fundal carcinomas were not positively recognized prior to operation. Of these, 75 per cent were associated with uterine myomas. In other words, pre-existing myomas may easily mask the symptoms produced by the fundal carcinomas. In young women pregnancy may be present. In the latter event, if therapeutic irradiation is employed, abortion is likely to occur. If abortion does not result injury to the fetus is prone to occur. This point has been amply proved by the work of Douglas P. Murphy.

Let me reiterate the many times published statement of Murphy's that neither ordinary radiation employed for roentgen diagnosis, nor even therapeutic preconception irradiation was found to be harmful if subsequent pregnancy occurs. The hazard comes only when postconception therapeutic irradiation is performed. Here the danger is very definite, but the differentiation between preconception and postconception therapeutic irradiation has been sharply drawn by Murphy in his valuable contributions to this subject. Incidentally, besides animal experimentations, Murphy's work constitutes the most extensive and painstaking contribution to the effects of irradiation in relation to pregnancy of which I have knowledge. Preconception therapeutic irradiation usually produces sterility. My belief is, and this is borne out by the extensive statistical study by Murphy, that the egg which has been injured by irradiation is incapable of fertilization.

The line between those cases of benign hemorrhage which require operation and those calling for irradiation is clear cut and well defined. Irradiation finds its ideal use in the cure of so-called functional uterine hemorrhage in women approaching the menopausal age. In the decision of whether to advise irradiation or

operation, we should remember that in operation we have a method of treatment which is eminently satisfactory in most cases and that irradiation is selected in only certain well-defined cases in which this form of treatment is distinctly superior. In properly selected cases irradiation is successful in about 95 per cent of cases. Most of our failures have occurred in that group of cases in which small doses of radium have been employed and in which some contraindication to the usual radiation dosage has existed. In large tumors which are not submitted to operation because of some contraindication to removal intrauterine irradiation with radium should be supplemented with roentgen therapy. Supposed myomas which develop or continue to grow after the definite establishment of the menopause should, I believe, be treated by operation because of the relatively high proportion of sarcoma in this group. The recent work of Kimbrough has brought about this important point. Intrauterine irradiation by radium at the time of the diagnostic curettage possesses some advantages over roentgen therapy, for by its use everything is over at once and no prolonged treatment after convalescence from the dilatation and curettage is necessary. Furthermore, in case a fundal carcinoma is discovered, the intrauterine radium probably tends to prevent dissemination of the carcinoma either by way of the lumen of the tubes, as suggested by Sampson, or even by the lymphatics or blood vessels. This I think is a rather important point.

Finally, I would like to stress the importance of at least a three year routine follow-up on all cases which have been treated by irradiation. This is particularly true in women who have been treated by irradiation for myoma.

Dr. Fall. How often is calcification of the uterus found following roentgen or radium therapy?

Dr. W. S. Newcomet, Philadelphia. I read a paper some years ago on this subject and the only comment was that it would be likely to cause a lot of deformed or feebleminded children. I wish to place on record one woman who had borne a child with hair lip and cleft palate before radiation therapy, who was treated for excessive bleeding by the roentgen ray, which controlled it nicely and about one year later she gave birth to a normal child.

Dr. George E. Pfahler, Philadelphia. Whenever this question of the influence of irradiation on subsequent children is brought up it reminds me of a patient I treated. A young woman came to me on the first anniversary of her wedding day. She had been previously operated upon for a fibroid tumor, was found to be pregnant so the abdomen was closed and she immediately aborted a monster. I was called upon to treat this fibroid growth, which I did, and without stopping menstruation at all for I was told just where the fibroid was located. A year later this woman gave birth to a normal child and has had three since. If I had treated her before her first pregnancy I would have had the credit of producing the monster.

Dr. David Y. Keith, Louisville, Ky. I wish to go on record as advocating the small dose of radiation in the young patient. Through an error in timing the dose in a girl aged seventeen she received 47 mg-hr. of radium. She had bled for three and a half years and following this had complete relief. She is now thirty-two years of age and has had a recurrence recently. She now has a hypothyroid condition and her bleeding was arrested this time by the use of thyroid extract in small doses.

This experience of 47 mg-hr. of intrauterine radium occurred fifteen years ago. Since that time I have treated approximately 20 cases of essential uterine hemorrhage in the young patient, none were over twenty-two years of age, never using more than 200 mg-hr. as the initial application. Only 3 patients have had recurrences requiring a second application.

Dr. Corscaden (closing). In regard to future pregnancy in a woman who has received a partial dose of radiotherapy, I think Dr. Murphy showed us definitely some years ago that the disturbances of pregnancy, parturition and in the children are about the same with children born following irradiation as in any obstetrical service. I think the evidence that some of these deformities do not appear until the second or third generation should be kept in mind while we are treating these patients. The whole thing is based on the theory of the alteration of the germ plasm, and that may act in a recessive manner and appear in later generations.

Another point: I think we should again emphasize the danger of using roentgen therapy in the pregnant woman. Investigators often give large doses of roentgen therapy to preg-

nant women. I had one case in which therapeutic abortion was attempted with the roentgen ray. Whatever the dosage was, the effect was incomplete and the child lived. The uterus was emptied. The child's cerebral hemispheres were replaced by cysts.

DR. SCHMITZ (closing). As far as the influence of irradiation on future pregnancies is concerned, I think we are all confused about this point, due chiefly to the observations made by Müller and others on the fruit fly. We should remember that the fruit fly is very different from the human being. Nürnberger has followed rabbits and dogs for fifteen generations and has seen no change. I think it is an important question and am glad it was raised. We should tell each patient that marital relations should not be had for at least six months following irradiation, for by that time the follicles that develop will probably be perfectly normal. We must not always blame the woman in these cases. I would like to know how often genes in the male are responsible for these monsters. We have four perfectly normal children following roentgen therapy and two following radium therapy. One abortion I think was produced by the woman and was not the result of the irradiation she had received four or five years before this pregnancy.

Vol. 33, No. 6

HAZARDS IN THE USE OF RADIUM IN CANCER*

By M. J. SITTENFIELD, M.D.
NEW YORK CITY

CLINICAL reports from the most reliable sources show definitely that those most proficient in the knowledge of the biophysical properties of the radioactive substances, and experts in the use of radium are unable entirely to avoid complications and untoward results.

Notwithstanding this, there are some writers who attribute the hazards following the application of radium to inaccurate dosage or an inadequate technique. Unfortunately, this latter impression prevails with surgeons, gynecologists and other clinicians who are least conversant with the biological reactions and practical use of radium.

From this point of view I have elected to discuss this unjustifiable attitude in the interest of those who have worked so earnestly in this branch of the medical sciences. The very fact that the ablest workers who are in constant touch with radiotherapy in cancer find it necessary to change their technique from time to time indicates that they have not as yet achieved such perfection that every case of cancer reacts satisfactorily to the radiant energy, or that they are able to prevent complications.

It is hardly feasible that a malignant disease as complex as cancer, made up of many variables, can be effectively coordinated with a physical agent of constant wave energy such as radium. However skillfully the treatment may be managed, the results anticipated are governed largely by conditions beyond our control and beyond the scope of our present knowledge. Because of this, biological and clinical reactions vary; therefore every radium worker attempts to employ a technique which will attain the most favorable result with the minimum amount of injury or damage to the tissues.

For example, despite the most skillful technique in the application of radium in cases of cancer of the cervix, the best authorities report complications ranging from a simple vaginitis or proctitis, hemorrhages, etc., up to a small percentage of fatal terminations. While on this subject, let me point to a report recently published by Dr. George Gray Ward of the Women's Hospital of New York. Of 560 women with cancer of the uterus in whom radium was used, 21 per cent experienced mild or severe forms of complication. The same holds true of cancer of the body of the uterus; in these 11 per cent sustained some untoward effect. Secondary hemorrhage occurred in quite a considerable proportion, and other writers cite that it happened in 10 per cent of their cases, besides the ulcerations and fistulae and other complications familiar to everybody. In 2 per cent death resulted from the complications incident to the use of radium.

The hazards and undesirable phenomena are not sufficiently stressed in the tremendous literature of radium in cancer. There seems to be a tendency by most writers to ignore or a sort of unexplained hesitancy about mentioning or describing these complications, or else they feel a personal reflection when they do appear. The reports of Dr. Ward and a few others concerning the complications in cancer of the uterus ought to stimulate other writers to elaborate upon these occurrences.

The most experienced radium workers realize the technical difficulties involved in a given case of cancer and appreciate that what seems to be accepted today as a rational technique may become obsolete and unwise in the very near future. So, too, they are aware that there are a number of factors which they cannot control, or anticipate conditions of which they have no previous knowledge. The frequent com-

* Read at the Nineteenth Annual Meeting, American Radium Society, Cleveland, Ohio, June 11–12, 1934.

plications which most workers have encountered are the best evidence that our present technique, though markedly advanced, is still imperfect, and the biological reaction to radiant energy is not precise.

While almost everyone concedes that radium in cancer of the uterus is the treatment par excellence, it must be remembered that it may be a most dangerous weapon in the hands of the inexperienced. Complications, slight or severe, are bound to occur even under the supervision of experts, but these hazards multiply when inexperienced individuals attempt to treat cancer with radium, especially if they are unfamiliar with the physics of radium, or not sufficiently grounded in the clinical or biological fundamentals of malignant disease.

In addition to the complications postulated in uterine cancer, there are unexplained latent effects which occur weeks or months later, and depend largely upon cumulative action which cannot be correctly appraised. For instance, it has not yet been satisfactorily explained what causes a skin which was adequately irradiated six or twelve months previously for a superficial lesion suddenly to break down, atrophy, ulcerate, necrose. From personal observations, and no doubt others have had similar experience, I have seen that one to three months following irradiation of a superficial skin lesion, the cutaneous tissue took on an inflammatory condition which later ended in a thickening of the subcutaneous structures and atrophy of the deeper tissues. In passing, permit me to refer to the telangiectases which appear from one-half to three years after an adequate dose of radium, to say nothing about the disagreeable burns and ulcers which follow a comparatively small dose of radium.

It is not my purpose to defend or condone carelessness or incompetency in the management of a highly specialized technique; however, there are numerous instances where cumulative, latent, radiobiological effects should be taken into account for these unforeseen complications. In general, an adequate dose of radium aims to obtain a localized reaction, yet everyone must have encountered general intoxication or even collapse due perhaps to absorption of cellular elements of the irradiated tumors.

In cases in which a local quiescent, chronic infection of the pelvic adnexa exists in women with uterine cancer, the application of radium in the uterus at times incites this low grade infection to flare up and give rise to local peritonitis and suppuration. It is not at all unlikely that the troublesome general reaction described by many writers on the subject of cancer of the uterus, as temperature, nausea and vomiting, may have as an underlying cause an exacerbation of a quiescent chronic septic condition within the pelvis, the presence of which was not determined or discovered at the time of irradiation.

I do not wish to underrate the value of the radioactive substances in the treatment of cancer, because of the complications and hazards which sometimes follow or attend the application of radiant energy; all of these are many times offset by its beneficial results, particularly in cases where every other method of treatment has failed.

Personally I feel, and have pointed out on former occasions, that the use of radiant energy is only in its infancy, because new radioactive substances are being discovered which disclose greater potentialities, and no doubt greater efficiency in the methods of application. Further still, we are approaching an era where selective radiation represents the ideal technique. While touching upon this point permit me to go a little further into this particular subject, at the risk of repeating myself. From experimental studies which we reported a few years ago before this Society, and which have since been corroborated by other investigators, and substantiated by clinical observations, it has been shown that it is possible by an accurately determined dose of radium to sterilize, so to

speak, the cancer cell itself without destroying the normal surrounding tissue. This of course applies only to tumors in which the malignant cell is more radiosensitive than the normal cells in which the tumor is situated. This selective radiation has the advantage that it limits its radiation effect to the cancer cell and at the same time leaves intact the adjacent tissue. The preservation of the surrounding tissue plays a most important part in the anticarcinomatous reaction of the organism against the invasion of the malignant growth.

In contrast to this selective radiation effect is the reaction of intensive radiation, where the action of the gamma rays of radium not alone destroys the cancer cell, but also the stroma and adjacent neighboring tissue by means of a caustic effect. This destructive process sacrifices the anticarcinomatous protective reaction upon which depends the success or failure of the therapeutic use of radium.

From this brief outline of the selective and caustic action of radium, it becomes increasingly evident how difficult it is to select the proper and accurate method of irradiation in a given case of cancer, the application of which requires skill and accuracy equal to that of a surgical procedure. To quote Meigs in his latest book, "It must be remembered that the use of radium seems notoriously simple to those who know nothing about it, but is extremely complicated to those who know a great deal." It is therefore regrettable that commercial radium laboratories take it upon themselves to determine the dosage in a case of cancer and to supply the radium to an inexperienced clinician, when they have no intimate knowledge of the patient with the cancer, nor of his general physical or organic condition.

A little reflection will convince everyone that constitutional factors and organic dysfunctions offer strong opposition to the application of radium. For example, cachexia constitutes a serious objection to any form of irradiation, also a blood of 40 per cent of hemoglobin or less with a cell count below three million. Uncontrolled diabetes and renal insufficiency come within the same category; in both of these conditions radium is not advisable unless uremic symptoms can be cleared up and a high non-protein nitrogen retention corrected. Chronic cystitis or involvement of the walls of the bladder in uterine and prostatic malignancies had better be left alone. Greatest care must be exercised in the vaginal fistulae of uterine cancer and radium treatment should be postponed until they are closed. The reaction in the mucous membrane of the bladder, incident to irradiation, may be simply an erythema as a primary reaction, though it may continue to secondary changes after three to four weeks, and finally there may appear a tertiary or latent reaction two to three years after the application of radium in the uterine as well as in the prostatic neoplasms. Nevertheless, in the presence of these grave malignant conditions, it may become an urgent problem to use radium in the full expectation that the complication arising therefrom may be very severe. Equally important are the cases with advanced cancer, in which it is purely a question of palliation, and even in these it has been our good fortune in a very few to obtain a permanent cure.

The limits of this paper prevent me from going more fully into the numerous complications and even fatalities which have been described by various authors, and the ablest and most experienced radium specialist highly trained in the physicobiological sciences and with a sound working knowledge of cancer, appreciates the hazards involved in the application of radium in the malignant diseases. He realizes that the sensitivity of the irradiated tissue, the quality and quantity of the energy absorbed, are the determining factors in the reaction in the tumor, because the greater the amount of energy absorbed, the more intense is the radiobiological effect upon the nuclear structure of the cell. It is this violent disintegration of the

cellular elements which gives rise to the primary reaction. The radiant energy absorbed in a very sensitive cell interferes greatly with its metabolic function, and brings about a great deal of nuclear damage, and the subsequent cell disintegration causes quite an intense reaction. On the other hand, in a tissue which absorbs only a minimum amount of radiation the reaction is very slight, and because of this is regarded by many workers as being radioresistant.

This so-called radioresistance of a tumor concerns another chapter, which is beyond the scope of this paper. Since the usefulness of radium in the treatment of cancer has extended into wider fields in the realm of medicine, it would be well to emphasize that the complications and hazards are in close accord with individual biological differences as well as with accumulative radiation effects.

In a general survey I have attempted at best to point out only the high spots regarding the hazards and the sequels incident to the use of radium. It is therefore of greatest importance for the radium specialist to grasp the enormous difficulties which go hand in hand with efficient planning, and experience and practice must lead him to give greater consideration to the very active and hidden forces of the organism. The study of the individual case before him must guide him to formulate a plan by which a particular method is to be pursued. Further still, the development of an improved technique must essentially rest upon a slight practical risk on a small scale, before experiments are attempted which involve greater hazards.

A TUMOR CLASSIFICATION FOR DIAGNOSTIC RADIOTHERAPY

By J. GERSHON-COHEN, M.D.
PHILADELPHIA, PENNSYLVANIA

THE diagnostic difficulties besetting the oncologic pathologist are generally recognized, but the aid he can obtain from the radiologist with diagnostic radiotherapy is not so well appreciated. True it is that this phase of tumor diagnosis is familiar to both the radiologist and pathologist but it has not been sufficiently emphasized or so consistently employed as it should in the routine diagnosis of tumors. We owe Desjardins[1] and Paterson[2] much for trying to crystallize this subject, and the following charts practically follow their recent publications. The charts are thought desirable only to help focus our attention more sharply, and to make available to us a working sheet for everyday usage and thus eventually improve this classification with more accurate radiological measurements and biological observations of the radiological effects. Their use has been found helpful in our work at the Skin and Cancer Hospital of Philadelphia and possibly this might be the experience of others who would use them.

A classification of cells according to their well-established radiosensitivities:

Most sensitive	(1) Lymphoid cells (lymphocytes)
	(2) Polymorphonuclear and eosinophilic leucocytes.
	(3) Epithelial cells:
	(a) Basal epithelium of certain secretory glands (especially of the salivary glands)
	(b) Basal epithelium (spermatogonial cells) of the testes and follicular epithelium of the ovary.
	(c) Basal epithelium of the skin, mucous membrane and certain organs such as stomach and small intestines.
	(d) Alveolar epithelium of the lungs and epithelium of the bile ducts (liver).
	(e) Epithelium of tubules of kidneys.
	(4) Endothelial cells of blood vessels, pleura and peritoneum.
	(5) Connective tissue cells.
	(6) Muscle cells
	(7) Bone cells
Least sensitive	(8) Nerve cells

All tumors are made up of one or another of these cellular elements, but since we must appraise their sensitivity *in vivo*, a rearrangement of tumors according to their relative sensitivity to radiation can be done as follows:

(1)	(a) Seminoma testis
	(b) Wilms' renal tumor
	Parotid tumors (in part) (those arising from basal epithelium)
	Chorionepithelioma
	Desmoid tumors (abdominal wall)
Lethal dose less than that of skin	(c) Thymoma (arising from thymic cells)
	Lymphosarcoma
	Endothelioma of bone (Ewing)
	Giant cell tumor
	Some other sarcomas
	(d) Hodgkin's disease
	(e) Rodent ulcer
	Transitional cell carcinoma
	Basal cell carcinoma
	Lymphoepithelioma
(2)	Epitheliomata
	(a) Most squamous cell carcinomata and some transitional cell carcinomas — sensitive enough to get good results.
	basal cell cancer
	lymphoepithelioma
Lethal dose near that of skin but still less than other normal tissues of tumor bed like muscle and connective tissue	(b) Carcinoma of mouth, tongue, cervix, skin, lip — tumor bed resistant enough to get good results.
	(c) Carcinoma of anus, scrotum, penis, vulva, tonsil, pharynx, breast, bladder, antrum — complex tumor bed-lethal dose therefore hard to achieve.

[1] Desjardins, A. U. Radiotherapy as method of identifying certain varieties of tumor. *J. Am. M. Ass.*, 1933, *101*, 1705–1710.

[2] Paterson, R. Classification of tumours in relation to radiosensitivity. *Brit. J. Radiol.*, 1933, *6*, 218–233.

	metastatic lymph nodes	
	(d) Carcinoma of esophagus lungs some gastro-intestinal	Lethal dose hard to deliver because of complex sensitive tumor bed.
(3) Lethal dose greater than skin and tissues comprising tumor bed	Adenocarcinomas (low sensitivity—uterine successfully treated because of high resistance of tumor bed; otherwise normal tissues have to be sacrificed to destroy this type)	
(4) Lethal dose greater than skin and of tumor bed tissues	osteogenic sarcomas fibrosarcoma neurofibrosarcoma true teratoma parotid tumors (parts) thymomas (parts) melanoma hypernephroma chondroma lipoma fibroma fibroids keloids	

In group (2), the lethal effect on tumors is chiefly determined by the radiosensitivity of the tumor bed so that many tongue and uterine carcinomata can be very successfully attacked, while esophageal, breast, gastrointestinal and some lung tumors are considerably more difficult.

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20th Annual Meeting: Atlantic City, N.J., June 10–11, 1935.

EDITORIALS

THE MARCH OF CHOLECYSTOGRAPHY

AS A rule, when a new test for disordered function or disease is presented, it is still incomplete technically, and much further experience is necessary to learn the proper interpretation of its results. In the enthusiasm aroused by its advent, improvements in the method and expansion of knowledge regarding the significance of the responses it elicits come quickly at first. Then as efforts at promotion continue, new problems arise, resistance to progress increases and advance is slowed, either actually or apparently. In the case of cholecystography, although it was more fully developed than most tests at the time of introduction, this sequence occurred with extraordinary rapidity, and such was the degree of efficiency attained that the procedure was in danger of becoming conventionalized both as to technique and interpretation.

That cholecystography is not yet ready for static standardization in either respect, but is still an inviting field for practical and profitable research, is shown by the articles that appeared in the May issue of this Journal. Stewart and Illick have elaborated Sandström's method of increasing and fractionating the oral dose of tetraiodophenolphthalein and have added the free administration of sugar preceding and during the examination, in order to make assurance doubly sure that the significance of absence or faintness of the shadow of the gallbladder will not be open to question. Controversy as to the relative merits of oral and intravenous administration has almost ceased since it has been shown repeatedly that if certain principles are respected the oral method is as reliable as the intravenous, and the few examiners who have not scrupulously followed these principles and are still skeptical of the oral procedure may do well to follow Stewart's recommendation, for he has contributed much to the efficiency of this method. The diagnostic criteria of deposits of calcium carbonate in the gallbladder, as described by Kornblum and Hall, should make for greater refinement in diagnosis. McNamee's experience with the intrahepatic gallbladder, although this anomaly is rare, has certain practical aspects. Moore furnishes additional confirmation of the fact that papilloma and other tumors of the gallbladder can often be recognized. Boyden's survey of "Phrygian cap" deformity of the gallbladder is admirable for its thoroughness. He shows conclusively that it is a congenital anomaly, occurs frequently, appears in various degrees and forms, and is devoid of clinical significance. This contribution is especially notable because there can be little doubt that "Phrygian cap" deformity often has been misconstrued as convincing evidence of pericholecystic adhesions attributable to past or present disease of the gallbladder, or has been made the basis of a diagnosis of hourglass deformity assumed to have clinical importance.

Thus, in a single issue of this Journal, are five important papers dealing with technical and interpretive features of cholecystography, all directed toward enhancing the accuracy of cholecystographic diagnosis, or, rather toward reducing still further the already low incidence of known error. The fact that the percentage of errors is low has been proved by operation and pathologic examination in many thousands of cases. However, clinicians sometimes point out that as only those patients who have marked symptoms of cholecystic disease usually are subjected to operation, the ratio of correct, positive, cholecystographic

diagnosis is likely to be high, but that if all the numerous patients who gave positive cholecystographic data, but who did not have definite symptoms, were operated on also, the record of cholecystography might not be as brilliant as it is.

It should be remembered that cholecystography is primarily a test of function at the time of examination. Only when gallstones, calcific deposits in the walls of the gallbladder, tumors, or deformity attributable to pericholecystic adhesions are demonstrable, is cholecystography a direct method of diagnosing disease. The roentgenologist will admit frankly that he cannot determine absolutely whether impaired function alone, as shown by absence or faintness of the shadow, is attributable to conditions unrelated to disease, to disease of other organs directly or reflexly affecting the ability of the gallbladder to receive and concentrate dye, or to disease of the biliary tract. As for the first alternative, the gallbladder evidently is not a capricious and temperamental organ, for the cholecystographic response is almost invariably normal among normal persons. As to the second, it has long been suspected that certain diseases, notably diabetes and exophthalmic goiter, may impair the function of a normal gallbladder, but the evidence is not convincing, and, at all events, it seems improbable that the presence of such diseases is the cause of many errors. Hence, until proof to the contrary is presented, the roentgenologist will continue to assume that impaired function probably implies the existence of biliary disease, whether symptoms of such disease are present or not. But, if a fact which should be obvious must be stressed, let it be noted well that absence or faintness of the shadow alone will not determine whether the biliary affection is transitory, chronic, mild or severe, or whether it is the probable cause of the patient's chief complaint. Consequently, roentgenologists have always maintained that cholecystographic data should never be made the sole basis of diagnosis or treatment but should be correlated with the clinical facts.

Inexperienced examiners are inclined to construe as faint any shadow which is of less than average density and this has been the cause of mistakes in diagnosis. Again and again warning has been given that there is no standard normal density and that unless the shadow is so faint on all films that it can be discerned only with difficulty, it should be considered normal. Absence of a shadow is more easily determined, but even here the inspection should be reasonably thorough. Evaluation of symptoms must be left to the clinician, but he will concede that when the cholecystograms reveal definite impairment of function of the gallbladder, absence of symptoms does not preclude the existence of biliary disease, for he realizes that "silent gallstones," for example, are not at all mythical and that often they are disclosed only by cholecystography.

On the whole, it may be asserted confidently that cholecystography is not losing ground but gaining, and that the proportion of definitely proved errors is smaller than that of many other accepted tests. Nevertheless, roentgenologists will continue to insist that their data be weighed in the light of the clinical facts in every instance, for however reliable the cholecystographic indications of biliary disease may be, it is essential also to determine the probable gravity of the affection, and that responsibility rests solely on the clinician.

B. R. Kirklin

WILLIAM DUANE
1872-1935

YOUNG PROFESSOR DUANE was a member of the faculty of the University of Colorado when, in 1898, Mme. Curie announced the discovery of radium, and, with her husband, made that humble Paris laboratory a place to which a youthful and enthusiastic physicist inevitably turned his steps when a leave of absence made further European study possible. What a satisfaction it must have been to Duane when Pierre Curie asked him if he would care to return there to work if the necessary financial arrangements could be made! They were made, Duane went again to Paris, and remained there, in the Curie Laboratory, as Radium Research Assist-

ant, from 1907 to 1913, an experience that shaped all his future work.

Dr. Duane returned to the United States to enter the Physics Department at Harvard University. He had already contributed to the literature a number of scientific papers, and, though he was now teaching, and was frequently sought for consultation by those who realized the value of his exact knowledge of the fundamental physical principles underlying the production and dosage measurements of radiant energy, he continued his researches. The same clarity that marked his papers made notable his lectures to the many graduate students who passed through his classrooms, and there was always the background of intelligent, painstaking physical measurements on which his fundamental conclusions were based. He had, too, an intimate, first-hand knowledge of the biological problems involved, and so was peculiarly helpful to the medical profession, which had to be introduced to the new physics, the understanding of which was so essential (as it still is) to the therapeutic use of radiations.

Thus, when, on March 6, 1935, Dr. Duane passed away at his home in Devon, Pennsylvania, after long disability patiently borne, there closed a life of true service.

He was born at Philadelphia, Pennsylvania, February 17, 1872, the son of Charles Williams and Emma Cushman (Lincoln) Duane. His father, a clergyman, and a direct descendent of Benjamin Franklin, was a graduate of the University of Pennsylvania.

William also was graduated from the University of Pennsylvania, with the class of 1892. He then entered Harvard University, as a senior, receiving an A.B. degree in 1893. He was Assistant in Physics, Harvard University, 1893–1895, and received a Master of Arts degree in 1895. In 1897 he received the degree of Doctor of Philosophy from the University of Berlin, and he was appointed Professor of Physics at the University of Colorado in 1898.

On December 27, 1899, Dr. Duane married Caroline Elise Ravenel, who was the daughter of Samuel Prioleau and Margaretta (Parker) Ravenel. He is survived by his widow and their three children, William Jr., Charles Prioleau, and Margaretta, now Mrs. Margaretta Duane Wood. A third son, Arthur Ravenel, died in 1928.

Dr. Duane held the following positions subsequent to 1913: Assistant Professor of Physics, Harvard University, 1913–1917; Professor of Biophysics, 1917–1934; Professor of Biophysics Emeritus 1934 until his death. He was Research Fellow for the Cancer Commission 1913–1918, and Research Fellow in Physics, Cancer Commission 1918–1928; 1933–1934. He was a Member of the Cancer Commission 1928–1933, and Research Fellow in Physics, Collis P. Huntington Memorial Hospital, 1928–1933.

His researches covered a wide range, as is evidenced by his many papers.

He was awarded the honorary degree of Sc.D. by the University of Colorado in 1923 and by the University of Pennsylvania in 1922. He was awarded the City of Philadelphia's John Scott Medal and Prize, the Comstock Prize of the National Academy of Sciences, and the Leonard Prize of the American Roentgen Ray Society.

Dr. Duane was a member of the National Academy of Sciences, the American Association for the Advancement of Science, the National Research Council, the American Physical Society, the American Philosophical Society, The Radiological Society of North America, the American Roentgen Ray Society, the Association for Cancer Research (president in 1923), the Massachusetts Medical Society, the American Academy of Arts and Sciences, Société de Physique, Phi Beta Kappa, and many others. He was a member of the Somerset and Harvard Clubs of Boston, the St. Botolph Club, and the Faculty Club of Cambridge.

WILLIAM D. COOLIDGE

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Atlantic City, N. J., Sept. 24–27, 1935.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. B. H. Orndoff, 2561 N. Clark Street, Chicago, Ill. Annual meeting: Atlantic City, N.J., 1935.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N.J., June 10–14, 1935.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting: Detroit, Mich., Dec. 2–6, 1935.

RADIOLOGICAL SECTION, BALTIMORE CITY MEDICAL SOCIETY
Secretary, Dr. W. B. Firor, 1100 N. Charles St., Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the fourth Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. H. J. Walton, 104 W. Madison St., Baltimore, Md. Annual meeting, St. Louis, Mo., Nov. 19–22, 1935.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N.Y. Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N.Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. H. G. Reineke, General Hospital, Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Otto Glasser, Cleveland Clinic. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. J. Payton, Miami Beach, Florida. Meetings held twice a year, May and November.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill. Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind. Meeting held the second Sunday in May annually.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting designed by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. E. F. Merrill, 30 W. 59th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse, N.Y. Three meetings a year—January, May, and November.

PACIFIC ROENTGEN CLUB
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, Williamsport, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas Loughery, Germantown Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N.Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital. Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN RAY SOCIETY
Secretary, Dr. P. C. Schnoebeien, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston. Meets at time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary-Treasurer, Dr. J. H. Smith, Lubbock, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Department of Roentgenology Staff Meeting
Secretary, Dr C. B. Peirce, University Hospital, Ann Arbor, Mich.
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Roentgen Club
Secretary, Dr. E. A. Pohle, 1300 University Ave , Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P.M.

Virginia Roentgen Ray Club
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

Society of Medical Radiology in Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Roentgen Society
Meets first Wednesday of each month, at 6.30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto, Japan. Meets bi-monthly on third Sunday.

MISSISSIPPI VALLEY MEDICAL SOCIETY

A new medical organization to be known as the Mississippi Valley Medical Society was formally organized at Quincy, Illinois, on April 8, 1935. The sole purpose of the new society is to hold an annual meeting each fall devoted to intensive post-graduate instruction and conducted by the leading clinical teachers of the United States. The programs will be eminently practical and of particular interest to the general practitioner.

The society will especially appeal to the physicians of Illinois, Missouri, and Iowa, and the annual meetings will be held in cities on the Mississippi River in these states. The first meeting will be held in Quincy during the month of October or November and will be a three-day session. The society has already been approved by the Adams County Medical Society of Illinois (Quincy), and the Marion-Ralls County Medical Society of Missouri (Hannibal).

The control of the organization is in the hands of a Board of Directors, consisting of one director to each 1,000 physicians in the states of Illinois, Missouri, and Iowa. The officers elected to serve for 1935 are: President: Dr. Walter Stevenson, Quincy, Illinois; President-Elect: Dr. H. B. Goodrich, Hannibal, Missouri; 1st Vice-President: Dr. H. P. Coleman, Canton, Illinois; 2nd Vice-President: Dr. E. A. Cunningham, Louisiana, Missouri; 3rd Vice-President: Dr. Wm. Rankin, Keokuk, Iowa; Secretary-Treasurer: Dr. Harold Swanberg, Quincy, Illinois.

Membership in the society will be open to all ethical physicians, it being a prerequisite that all members hold membership in their respective state medical societies. In order to get started quickly, the Board of Directors has elected to place the membership fee and dues for the first year at only $3.00 and life membership at $25.00, provided these are paid before the time of the annual meeting. Charter membership will close July 1, 1935. Members will attend the annual meetings without payment of a registration fee.

The Board of Directors is desirous of securing one thousand physicians as charter members in order to provide a caliber of program at the Quincy meeting that has never been equalled in this section of the Mississippi Valley. Physicians interested in the new organization are urged to communicate with Harold Swanberg, M. D., Secretary-Treasurer, 211–224 W. C. U. Bldg., Quincy, Illinois.

AUSTRIAN ROENTGEN SOCIETY

The Austrian Roentgen Society (Gesellschaft für Röntgenkunde und Strahlenforschung) was formed in Vienna on February 2, 1935, in the presence of representatives of all federal states. Thus, in a manner similar to the arrangements of other countries, a union of the roentgenologists of the Austrian Federal States was brought about for the purpose of scientific intercourse, the holding of congresses, as well as the necessary representation at international meetings. The following officers were elected: President: Prof. Kienböck, Vienna; Managing Vice-President: Staatsrat Doz. Wieser, Vienna; Vice-Presidents: Prof. Gottwald Schwarz, Vienna; Prof. Leb, Graz, Doz. Palugyay, Vienna; Secretary: Doz. E. G. Mayer, Vienna; Assistant Secretaries: Doz. Eisler, Vienna, Medrat. Kleinschmidt, Linz; Treasurer: Prim, Krisser, Vienna. Professor L. Freund of Vienna, a pioneer in roentgen therapy, was elected an honorary member. The status of the Vienna Roentgen Society (Wiener Gesellschaft für Röntgenkunde und Strahlenforschung) remains unchanged by the formation of this new society.

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DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., M.S., 105 Rutledge Ave., Charleston, S. C.

A SIMPLE AND EFFICIENT TABLE FOR POST-MORTEM CHEST ROENTGENOGRAPHY*

By W. LYLE ALLRED, M.D., *and* L. H. GARLAND, M.D.

SAN FRANCISCO, CALIFORNIA

ONE of the principal drawbacks to post-mortem roentgenographic study of chests, and therefore a major factor in discouraging attempts to correlate post-mortem roentgen and pathological findings, is the difficulty met with in getting the subject into a vertical position. A simple table is described herein which makes this easy.

The table top is a rectangular wooden frame, 22×72 inches, with the upper third covered by aluminum 1 mm. thick and the lower two-thirds by three-ply veneer. It is hung near its middle on two trunnions, the suspension being offset so that the table top hangs 6 inches below the points of suspension. This keeps the center of gravity of the average-sized human body slightly below the level of the suspension, and thus, when the table is loaded, it is not only easy to raise the cadaver into a vertical position,

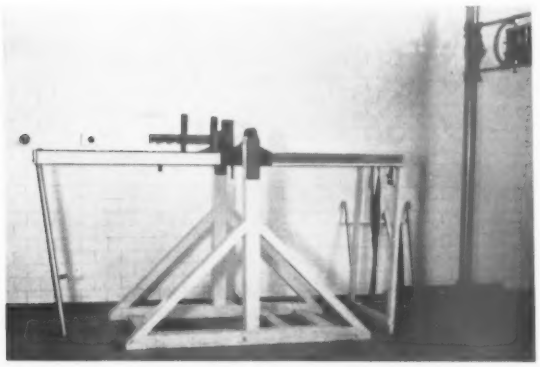

Fig. 1. Tilting table for post-mortem roentgen examination; table in horizontal position. The table is of the same height as the guerney on which the patient is brought to the morgue. The adjustable saddle device is lifted off before transferring the patient to the table. The legs on the left fold up and are retained by a simple catch. The legs on the right merely lie against the table in the upright position (see Fig. 2). Note the cassette holder lying against the rear wall on the right.

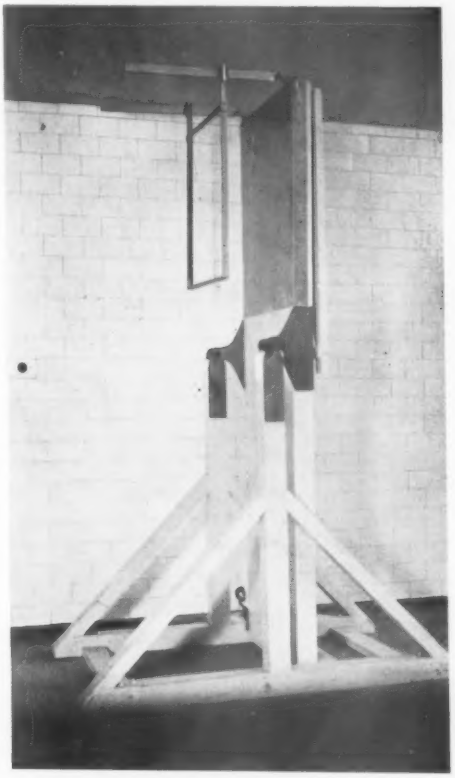

Fig. 2. Tilting table for post-mortem roentgen examination; table upright. Note the cassette holder which has been hung on two metal arms inserted into slots at the head end of the table. Note aluminum cover over upper third of table (traversed by roentgen rays in making vertical chest exposures).

but the loaded table is in unstable equilibrium, tending always to return to hori-

* From the X-Ray Department of San Francisco Hospital (Department of Public Health and Stanford University School of Medicine, San Francisco, California).

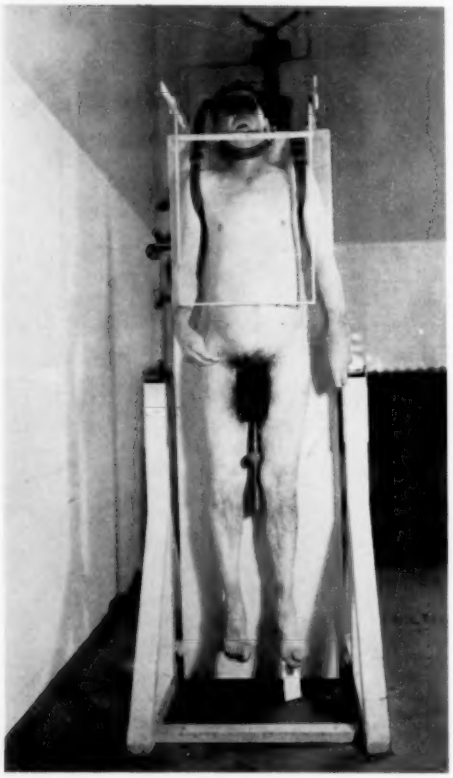

FIG. 3. Tilting table for post-mortem roentgen examination; patient in vertical position. Note that he is supported by the adjustable wooden "saddle" under the perineum, and by simple straps under the arm-pits and the chin. These straps are firmly secured by rivets to the upper end of the table. The white object below the left foot is merely the morgue identification label. The cassette has been removed from the cassette holder to illustrate the straps, etc.

zontal and never to pitch forward, even when the cadaver is upright (see Figs. 1 and 2).

At the head end are two legs so hinged that they always hang vertically, and never permit the head to drop below the horizontal level. At the foot is a single leg which is drawn up and held by a catch when the table is to be swung to upright position. The table is held upright by a catch at *c* (Fig. 2) which automatically locks the table in this position. It is released by foot pressure when the table is to be returned to horizontal.

All of the wooden parts are heavily coated with white enamel which permits frequent cleansing.

The cadaver is laid face up on the horizontal table with the shoulders at a predetermined level. A strap (Figs. 1 and 3) is buckled under each arm pit, and one under the chin. A demountable "saddle," shown in detail in Figure 4, is put in place through two holes in the table top, and fixed by a pin. The saddle is then adjusted by the sliding notched piece, till it makes firm pressure under the symphysis pubis. This saddle supports the greater part of the weight when the cadaver is upright. The table is then swung to upright position. Two metal arms (Fig. 2) support a rectangular frame, into which a 14″×17″ cassette can be slipped, and the exposure is then made from a tube stand 6 ft. behind the "standing" cadaver, through the aluminum table top.

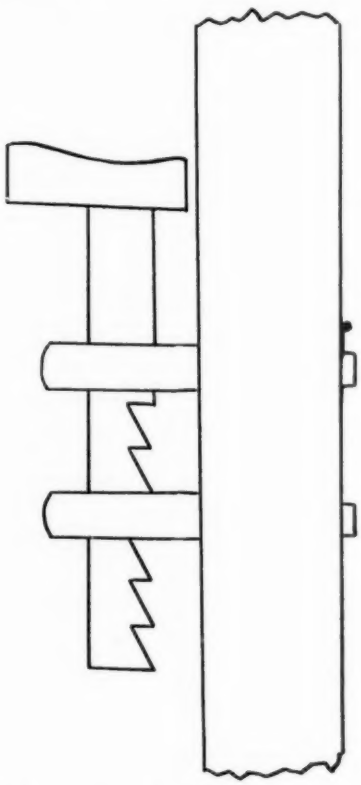

FIG. 4. Diagram showing the construction of the adjustable wooden "saddle." The ratchet is adjusted when the patient is in the horizontal position; when vertical, the weight of body keeps it secured.

The advantages of such an arrangement are:

(1) Ease and rapidity with which post-mortem chest roentgenograms can be made. The entire procedure need take no more than three or four minutes.

(2) Accuracy of positioning and centering. The table is bolted to the floor, and the position of the tube stand is marked on the floor.

(3) No danger of mutilation of the body. The weight is supported chiefly at the pelvis.

(4) Cleanliness. The cadaver is always supine or upright, thus minimizing the chance of spilling of gastric contents.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

ENGELSTAD, ROLF BULL. Radiumbehandlung von abdominaler Aktinomykose. (Radium treatment of abdominal actinomycosis.) *Strahlentherapie*, 1933, *47*, 547–550.

The results of radiotherapy in actinomycosis vary considerably, depending on the localization of the disease. In the cervicofacial forms the results are very good; in the thoracic and pulmonary forms they are poor. The same is true of intestinal actinomycosis. A few cases of successful treatment with roentgen rays have been reported, but apparently radium has rarely been tried.

The author reports a case in a young man of twenty-two, who came for treatment for an intestinal fistula and an infiltration of the wall of the abdomen in the ileocecal region. Examination showed actinomyces. Radium treatment was begun at once. A prosthesis containing 152 mg. radium was applied at a distance of 3 cm. from the skin over the fistula and the infiltration. It covered a surface 16×16 cm. in size and gave a daily dose of 6 Dominici, filter 1 mm. platinum. In the course of ten days the patient was given a dose of 60 Dominici. There was slight erythema of the irradiated part of the skin. The infiltration was unchanged. Gradually the fistula closed and the infiltration disappeared. Six months after the irradiation the patient was completely free of symptoms. The author thinks it probable that the cure is permanent. He believes that the former failures in the treatment of this disease were due to improper technique. With the contact application formerly used or only a very short distance between the radium and the skin, the irradiation is necessarily inhomogeneous and the depth dose small. The total dose must be as large as can be borne without injuring the skin permanently, that is, it must be a dose that causes radioepidermitis, such as is used in the treatment of malignant tumors. He thinks it probable that better results will be obtained with protracted fractional irradiation with hard strongly filtered rays by Coutard's method.—*Audrey G. Morgan.*

ERNST, GEORG. Die Hypophysenvorderlappenhormontherapie in Kombination mit der Strahlenbehandlung hinsichtlich ihrer Wirkung auf das Genitalkarzinom der Frau. (The combination of radiotherapy and treatment with hormone of the anterior lobe of the hypophysis in genital carcinoma in women.) *Strahlentherapie*, 1933, *48*, 552–561.

The author used horpan, which is an extract of the anterior lobe of the hypophysis, in the treatment of genital carcinoma in association

with roentgen irradiation. Horpan contains only hormone A which is the follicle hormone, unlike prolan which also contains hormone B, the luteinizing hormone. The horpan was dissolved in 20 per cent grape sugar solution and given in individual dosages of not over 100 mouse units and total dosages of not more than 3,000 mouse units. Unlike Zondek, the author found that the hormone therapy had very little effect in these cases. He treated 6 cases, 4 of which are described in detail. He found horpan of great value, however, in cases of ovarian dysfunction.—*Audrey G. Morgan.*

Schroeder, K., and Manigold, K. Ist eine Abstufung der Strahlendosis zur Erzielung der Dauermenolyse erwünscht und möglich? (Is graduated dosage possible and desirable in bringing about permanent amenorrhea?) *Strahlentherapie*, 1933, *47*, 658–662.

There is still a discussion as to whether myomata and metropathies should be treated by a single ovarian dose or by graduated dosage, and there is no general agreement as to what the single ovarian dose should be. The authors report their results in two groups of cases, in one of which a single ovarian dose of 320 r was given, and in the other graduated dosage. The technical conditions with reference to apparatus, filtration, focus-skin distance and the size of the fields were the same in the two groups. Among the total number of 472 patients, there were 98.4 per cent cures and 1.6 per cent failures with graduated dosage, and 96.9 per cent cures and 3.1 per cent failures with a single ovarian dose. The attainment of permanent amenorrhea was considered a cure. There were severe symptoms of the menopause in only 26 per cent of the cases treated with graduated dosage, and in 60 per cent of the cases treated with the single ovarian dose. The dose required to attain the desired results was 30 to 40 per cent smaller with graduated dosage than with a single dose. The higher the dosage the more frequent and more severe the symptoms of the menopause. Another advantage of the graduated dosage is that there is considerably less roentgen sickness in these cases, particularly after small doses.—*Audrey G. Morgan.*

Gál, Felix. Die Radiumbehandlung gutartiger Uterusblutungen. (The radium treatment of benign hemorrhages of the uterus.) *Strahlentherapie*, 1933, *47*, 663–671.

Small doses of radium should be used in the treatment of benign hemorrhages of the uterus. The author generally uses only 20 mg. radium in brass tubes 1.5 to 2 mm. thick. Before they are introduced the cervix is dilated for four to five hours with laminaria tents. The radium tube is left in position for twenty-four hours, and after its removal the uterus is irrigated. In some cases after curettage only 10 mg. were used and amenorrhea brought about for several months. The treatment never caused any complications. With these small doses the hemorrhage does not always stop immediately. In 5 cases there was still slight hemorrhage for two or three weeks, which was soon followed, however, by total amenorrhea. The use of small doses is to be recommended in young patients because the amenorrhea is not necessarily permanent. If menstruation occurs and is again irregular or protracted, another radium treatment can be given. In older women one application of radium generally brings about permanent amenorrhea. This treatment is not followed by disagreeable symptoms of the menopause. This treatment is not as generally used as roentgen treatment, probably because in the beginning it was used in unsuitable cases and too large doses were used, resulting in injury or even death. The results of this treatment are very satisfactory when it is confined to uncomplicated metropathies and small myomas. Kupferberg recommends the use of radium also in cases of severe juvenile hemorrhage. In such cases the radium is only applied for a short time so that menstruation will be re-established. In the majority of the author's cases of myoma the tumors disappeared after the treatment.—*Audrey G. Morgan.*

Philipp, E. Zur Therapie der Kollumkarzinome. (Treatment of carcinoma of the cervix.) *Strahlentherapie*, 1933, *47*, 646–650.

So much emphasis is placed on radiotherapy at roentgen congresses that the importance of surgical treatment is apt to be forgotten, but the roentgen therapist should know what the results of surgical treatment are in order to compare them with the results in his own field. The author reports the results at the Berlin University Gynecological Clinic since 1913 where they have operated on some of the cases and irradiated some, and used the combined method for some.

A table is given showing the results in 312 cases of carcinoma of the cervix treated from

1926 to 1927 when vaginal radical operation was being used. Among the 312 cases, 91 were cured, or 29 per cent; 109 were operated upon, and of these 48 were cured, or 44 per cent; 201 were irradiated, and 43 of these were cured, or 21.5 per cent. The operated cases were almost all in good condition, while some of those that were irradiated were very advanced cases. Another table is given showing the carcinomas treated from 1913 to 1926, when the Wertheim radical operation was being used. The total number of cases treated was 2,090, with an absolute cure of 26.9 per cent. Of these, 532 were operated upon with 255 cures, or 48 per cent; 1,555 were irradiated with 317 cures, or 19.8 per cent.

These figures show the great value of operative treatment. The primary mortality from infection in operation has been greatly reduced. Virulence tests should be made and cases with virulent streptococci should be given preliminary irradiation. In the radiotherapy of carcinoma of the cervix, radium should be used rather than roentgen rays. The author's clinic uses moderate doses of 5,000 to 6,000 mg-hr. Prolongation of the time gives better results. The author's statistics show that there are fewer late recurrences in cases that are operated upon than in those treated by radiotherapy. Among 256 women operated upon by the Wertheim method there were 4.3 per cent recurrences after five years, while among 264 cases that were irradiated there were 6 per cent. The number of women restored to complete capacity for work was somewhat higher in the operated group than in the irradiated group.

As the result of their experience, the author's clinic has adopted the following rules for treatment: All operable carcinomas are operated upon at once, except in young women under thirty years of age, and in cases with positive virulence tests. Young women under thirty are treated with radium for the purpose of preserving a functioning vagina, which is not always possible on operation. If the effect of the irradiation is not good, operation is performed. Patients with positive virulence tests are treated with radium until the bacteria become avirulent, which generally requires about six weeks. Radium is also used in cases in which operation is contraindicated. Inoperable carcinomata are treated with radium and if they become operable are operated upon. If they do not become operable they are treated a second time with radium, or in some cases with roentgen irradiation. Postoperative treatment with roentgen rays is given in all operated cases.—*Audrey G. Morgan.*

HANDLEY, W. SAMPSON. The treatment of x-ray carcinoma and x-ray dermatitis. *Lancet*, Jan. 20, 1934, *1*, 120–122.

The author advocates cutting the main line of dissemination at an early stage when the hand or fingers are involved by roentgen carcinoma, i.e., the lymphatics, thus confining the spread of the lesion to the region of the hand or the forearm. To accomplish this, it is suggested that a radical axillary excision be accompanied by removal of the supratrochlear gland and the lymphatic trunks connecting the two. The subclavicular glands of the axillary group must not be overlooked. Alcoholic injection of the intercosto-humeral nerve, if exposed, will avoid postoperative neuralgic pain. A negative report on the removed glands does not invalidate the operation, since its object is preventive and anticipatory, but, on the contrary, assures one that the dissection has been done in time. The wearing of a glove soaked in staphylococcus antivirus is advised for roentgen dermatitis.—*W. R. Brooksher.*

v. OETTINGEN, E. N. Parotitis und Röntgentherapie. (Parotitis and roentgen therapy.) *Strahlentherapie*, 1933, *46*, 651–654.

From 1926 to 1932 the author treated 25 hospital cases of parotitis with roentgen irradiation. Only 4 of these patients were sent to the hospital for chronic parotitis, 5 of them had suffered injuries of the face in which the parotid gland also was affected. All of the others were cases of postoperative parotitis. They were irradiated with 20 to 25 per cent of a skin erythema dose. The results were very unsatisfactory. There was no effect in the 4 cases sent in for parotitis nor in the 5 traumatic cases, and no considerable improvement except in 4 of the postoperative cases. In 13 of the cases incision was necessary on which the patient's condition improved. Fried reports excellent results from roentgen treatment in 24 out of 31 cases of parotitis. The author thinks that the difference in his results and those of Fried may be due to the difference in the nature of the cases. Fried's cases were ordinary acute inflammation, while in the author's cases fermentative autodigestive changes in the gland parenchyma were the most prominent feature. In such cases the

ordinary doses used for inflammation are not effective. The author believes that with a dosage of at least 80 per cent of a skin erythema dose, good results might be obtained in these cases also, but he has not had occasion to try this method as it is impossible to make a differential diagnosis between cases of ordinary inflammation and those of autodigestive origin. He does not believe, however, that the larger doses would do any harm, even in inflammatory cases, as he has in recent years used as much as 100 per cent of a skin erythema dose in cases of actinomycosis.—*Audrey G. Morgan.*

Altschul, Walter, and Schiller, Viktor. Behandlung chirurgischer Tuberkulose in Flachlandsanatorien. (Treatment of surgical tuberculosis in sanatoria at low altitudes.) *Strahlentherapie*, 1933, *46*, 645–650.

The authors report the results of 402 cases of surgical tuberculosis treated at the sanatorium in Wlaschim from 1927 to 1931. The work of this sanatorium is confined to the treatment of surgical tuberculosis, the majority of the cases being referred after treatment in other hospitals or at home. Of these cases, 256 were closed, 248 of them being old cases, and 8 recent cases. Of the 146 open cases, 43 were uncomplicated, and 103 had mixed infection with fever.

In the closed cases the results were very satisfactory, the treatment rarely requiring more than a year. In the first stage only medical and climatic treatment is given, with fresh air and rest, calcium, arsenic, codliver oil, and in suitable cases iodides. The object is to detoxicate the body and bring about normal metabolism before giving any more radical treatment. The general condition improves under this treatment but there is no change in the local focus until the second stage when intensive heliotherapy and several series of roentgen irradiations are given. The third stage is characterized by rapid disappearance of tuberculous granulation tissue and retrogression of infiltrations and enlargements of the bones. In the majority of cases complete restoration to normal was brought about or only slight functional disturbance persisted. In cases with extensive bone destruction, of course complete restoration to normal was impossible. In a few cases cure was accompanied by complete ankylosis.

Of course in the febrile cases treatment required a much longer time as closure of the fistulas is a very slow process. The general rest and fresh air treatment must be protracted in these cases. Local roentgen therapy, which is of very great value, must be adapted to the individual case and the patient must be kept under hospital observation, as, otherwise, damage may be done by overdosage applied to tuberculous tissues which are very sensitive to irradiation. The functional results were much better in the cases that were irradiated than the ones that were not irradiated.

On the whole, the results were excellent. About 60 per cent of the cases were restored to complete working capacity and there were only about 10 per cent in which no good results were obtained. In view of the fact that most of the cases were old and far advanced, these results are good. It is hoped, however, that they will be still better when the new hospital is completed that is being built on a site 530 m. above sea level open toward the south and protected from winds.—*Audrey G. Morgan.*

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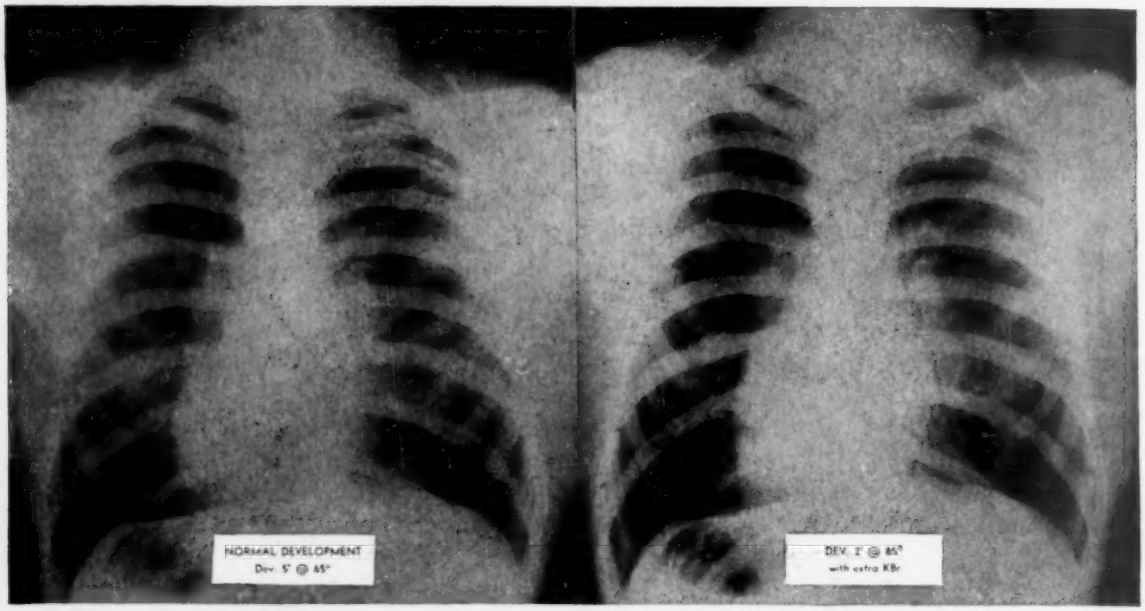

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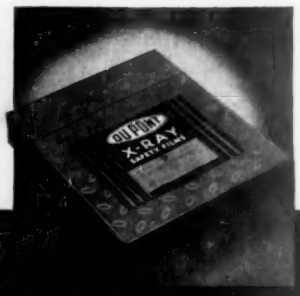

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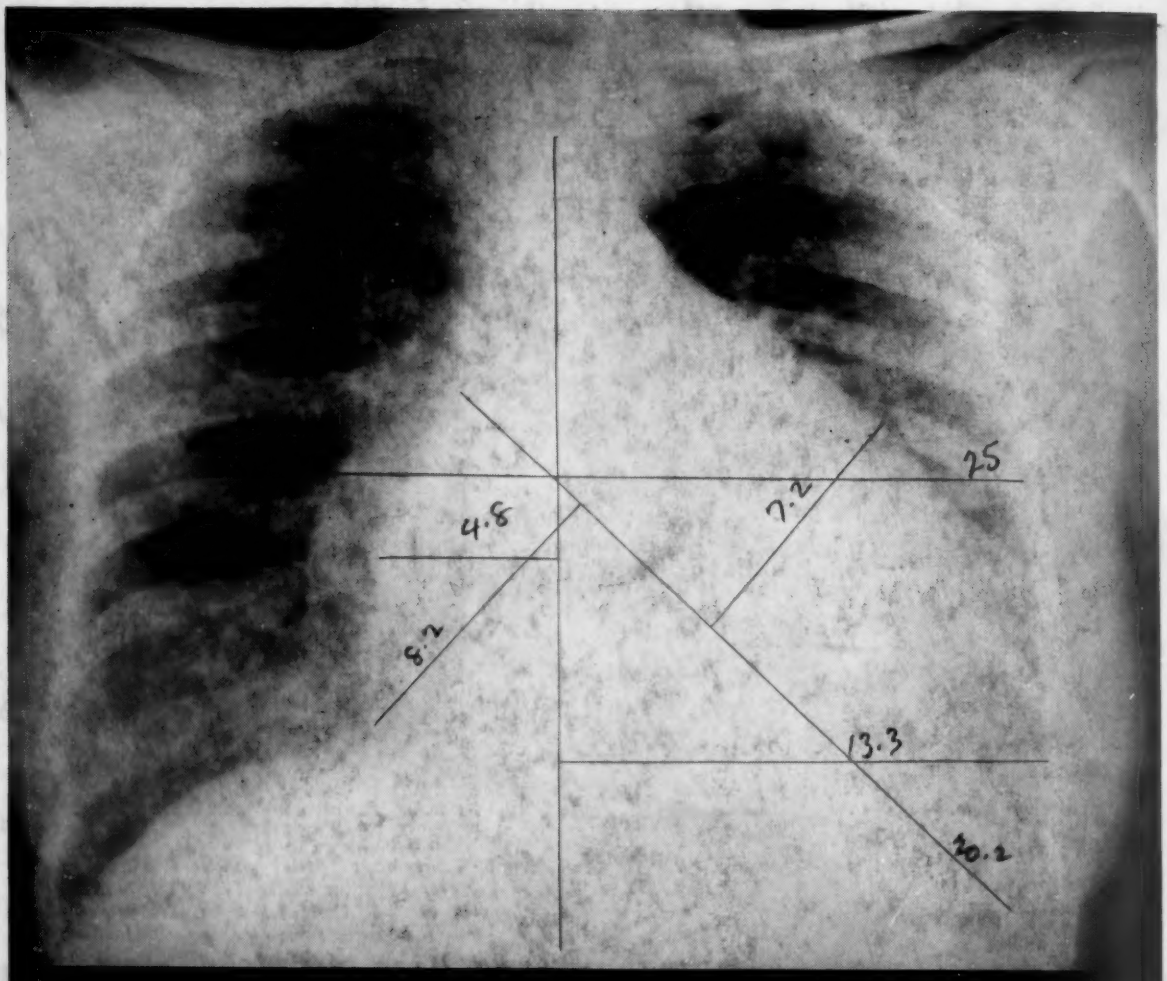

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